



January 11, 2023

Mr. Rob Kondreck
On-Scene Coordinator
U.S. Environmental Protection Agency, Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604

Subject: Air Monitoring and Sampling Plan, Revision 0
LaSalle Chemical Fire ER
EPA Contract Number: 68-HE-0519-D0005
Task Order-Task Order Line Item Number: TBD
Document Tracking Number: 1620

Dear Mr. Kondreck:

The Tetra Tech, Inc. Superfund Technical Assessment and Response Team (START) is submitting the enclosed Air Monitoring and Sampling Plan for the area surrounding the release at the LaSalle Chemical Fire Site (the site) for your review and approval. This plan summarizes the air monitoring and sampling activities planned for January 2023 at the site in La Salle, La Salle County, Illinois.

If you have any questions regarding this plan, please contact me at 312-201-7763 or via e-mail at alexis.enright@tetrattech.com.

Sincerely,

Alexis Enright
Project Manager

Enclosure

cc: TOLIN file
Karl Schultz, Tetra Tech Program Manager

**AIR MONITORING AND SAMPLING PLAN
LASALLE CHEMICAL FIRE SITE
LA SALLE, LA SALLE COUNTY, ILLINOIS**

REVISION 0

Prepared for

**U.S. ENVIRONMENTAL PROTECTION AGENCY
Superfund and Emergency Management Division
Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604**

Submitted by

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1. EPA STANDARD OPERATING PROCEDURES

1.0 INTRODUCTION

Under Contract Number 68-HE-0519-D0005, Task Order-Task Order Line Item Number (TO-TOLIN) to be determined (TBD), U.S. Environmental Protection Agency (EPA) Region 5 tasked the Tetra Tech, Inc. (Tetra Tech) Superfund Technical Assessment and Response Team (START) to assist with air monitoring at the area surrounding the release at the LaSalle Chemical Fire site (the site) located in La Salle, La Salle County, Illinois (Appendix A, Figure 1). The overall goal of the air monitoring effort is to assess levels of particulate matter, organic vapor contamination, and other chemical concentrations in the air in the areas surrounding the release (Appendix A, Figure 2) and to determine whether these levels pose a threat to human health and the environment.

Air and water sampling activities have been included in this air monitoring and sampling plan (AMSP) as a contingency measure. If tasked, the overall goal of the air and water sampling effort is to assess levels of particulate matter, organic vapor contamination, and other chemical concentrations in the air and runoff water in the areas surrounding the release (Appendix A, Figure 2) and to determine whether these levels pose a threat to human health and the environment.

This AMSP describes the monitoring, sampling, analytical, and quality assurance and quality control (QA/QC) requirements for activities at the site. Figures for this AMSP are provided in Appendix A. Tetra Tech standard operating procedures (SOP) to be used during this investigation are provided in Appendix B. EPA SOPs to be used during this investigation are provided in Attachment 1.

2.0 SCOPE OF WORK

In accordance with the TO-TOLIN and/or verbal authorization, the EPA On-Scene Coordinator (OSC) tasked START with the following objectives:

- Record meteorological data, including temperature, wind direction, wind speed, and current weather conditions.
- Conduct real-time air monitoring of the site at roaming and fixed monitoring locations.
- Document monitoring activities and locations via photographs, digital data capture forms, and written field notes.
- Document and summarize the findings in a summary report.

In addition, if directed by EPA, Tetra Tech may conduct one or more of the following activities:

- Collect outdoor (ambient) air samples at the stationary monitoring locations for laboratory analysis of volatile organic compounds (VOC).
- Conduct real-time water quality monitoring of nearby surface water bodies.

- Collect water samples from fire suppression runoff for laboratory analysis of metals, VOC, pesticides and herbicides, and semivolatile organic compounds (SVOC).
- Document sampling activities and locations via photographs, digital data capture forms, and written field notes.
- Prepare data validation reports after receipt of final data packages from the laboratory.
- Perform data management using SCRIBE software and geographic information systems (GIS) mapping to track field team progress.

3.0 PROJECT TEAM

The personnel listed in the table below will be involved in planning or technical activities for this site. The OSC and each member of the field team will receive a copy of this AMSP, and a copy will be retained in the site file. Key project personnel are listed in Table 1 below.

TABLE 1: KEY PROJECT PERSONNEL

Personnel	Title	Organization	Phone	Email
Rob Kondreck	OSC	EPA	312-758-6517	Kondreck.Robert@epa.gov
Alexis Enright	Project Manager	START	219-427-4067	Alexis.Enright@tetrattech.com
Kris Schnoes	QA Manager	START	312-201-7480	Kris.Schnoes@tetrattech.com
Helen Fournet	Field Staff	START	504-444-8740	Helen.Fournet@tetrattech.com
Nichole Boyea	Field Staff	START	262-501-2905	Nichole.Boyea@tetrattech.com
Joe Sanders	Field Staff	START	309-830-0754	Joe.Sanders@tetrattech.com
Bruce Welch	Project Chemist	START	312-201-7430	Bruce.Welch@tetrattech.com

Notes:

EPA U.S. Environmental Protection Agency
 OSC On-Scene Coordinator
 QA Quality assurance
 START Superfund Technical Assessment and Response Team

4.0 SITE LOCATION AND DESCRIPTION

The Site consists of the area surrounding the Carus Chemical Facility (Carus) located at 1500 8th Street in La Salle, Illinois (Appendix A, Figure 1). On the morning of January 11, 2023, a fire erupted at the Carus facility with no reported injuries. The City of La Salle encouraged residents near the fire to remain indoors. The Carus facility produces chemicals used to treat drinking water, air, and soil. The exact chemicals involved in the fire are not known. The facility lies less than half a mile west of the Little Vermillion River, which flows into the Illinois River approximately 1 mile downstream from the site of the fire. The area around the facility is mixed use with light industrial, commercial, and residential properties in close proximity. There are several schools and parks within half a mile of the Carus facility.

5.0 DATA QUALITY OBJECTIVES

As part of the project planning process, START used the data quality objective (DQO) process to (1) clarify study objectives and decisions to be made based on the data collected; (2) define the most appropriate types of data to collect; (3) determine the most appropriate conditions for collecting the data; and (4) specify performance or acceptance criteria that will be used as the basis for establishing the quantity and quality of data needed to support the decision. The DQO development process is a recommended approach for ensuring appropriate planning for environmental investigations, as described in EPA's "Guidance on Systematic Planning Using the Data Quality Objectives Process" (EPA 2006). Developing DQO is a seven-step process. Each step of the DQO process is provided below.

- 1. State the Problem:** As documented in Section 4.0, the fire at the Carus facility consumed structures that housed unknown potentially hazardous materials. The resulting plume and vapors may pose a risk to human health and the environment in the surrounding area. Hazardous materials may also be transported in fire suppression runoff water to surface water bodies; the Little Vermillion River, which flows into the Illinois River, is less than half a mile west of the site. The problem is anticipated to evolve as more information becomes available and as the fire is extinguished.
- 2. Identify the Goal of the Study:** Determine if the conditions at the site and in the surrounding areas present a threat to the public health or welfare or present a threat to the environment. Provide observations and data to EPA so they can make informed response decisions and provide useful information to local authorities and other stakeholders.
- 3. Identify Information Inputs:** The necessary information will be obtained by conducting air monitoring and if tasked, air and surface water sampling. Air monitoring will be conducted to obtain real-time measurements for particulate matter (PM), VOC, oxygen (O₂), carbon monoxide (CO), hydrogen sulfide (H₂S), the lower explosion limit (LEL), ammonia (NH₃), hydrogen chloride (HCl), hydrogen cyanide (HCN) and any other site-specific air toxics of concern. Air monitoring results will be compared to the action levels presented in Section 7.0. Air samples collected at the Site will be submitted to an accredited laboratory for VOC analysis; water samples will be submitted to an accredited laboratory for metals, pesticides and herbicides, SVOC, and VOC analyses as described in Section 7.0. Analytical results for air samples will be compared to EPA Regional Screening Levels (RSLs) for residential air (EPA 2022). Analytical results for surface water samples will be compared to the Illinois Environmental Protection Agency (IEPA) Derived Water Quality Criteria List (IEPA 2019).

4. **Define Boundaries of the Study:** The spatial and temporal boundaries of the study are not yet defined and are expected to evolve throughout the duration of the response. Spatial and temporal boundaries will be documented in the emergency response summary report, as listed in Table 2 in Section 6.0.
5. **Develop the Analytic Approach:** The analytic approach is documented in Section 7.0.
6. **Specify Performance or Acceptance Criteria:** The performance and acceptance criteria include EPA RSLs, IEPA Derived Water Quality Criteria List, and laboratory-specific criteria documented in the START QAPP (EPA 2022, IEPA 2019, Tetra Tech 2022). START has confirmed that the laboratory reporting limits for all analyses meet the associated RSL or IEPA Derived Water Quality Criterion. Stage 3 data validation is required in accordance with the procedures documented in the START QAPP (Tetra Tech 2022).
7. **Develop Plan for Obtaining Data:** The plan for obtaining data is documenting in Section 7.0.

6.0 PROPOSED SCHEDULE

Monitoring and sampling activities are planned for January 2023. The exact sample locations and number of samples will be determined in the field based on field conditions. Preliminary VOC results for air samples and preliminary metals, pesticides and herbicides, SVOC, and VOC results for water samples submitted for laboratory analysis will be requested as quickly as the laboratory can provide them, likely a 24- to 48-hour turnaround time.

Laboratory analytical data will be validated by a START chemist after full Level IV data packages become available (Stage 3 validation). The validated analytical results and other findings will be provided to EPA in an emergency response summary report. The anticipated schedule is outlined in Table 2 below.

TABLE 2: PROPOSED SCHEDULE

Activities	Anticipated Date of Initiation	Anticipated Date of Completion	Deliverables	Deliverable Due Date
AMSP preparation	January 11, 2023	January 13, 2023	AMSP	January 13, 2023
Sample collection	January 2023	January 2023	Logbooks, GIS data	Not applicable
Laboratory analysis	January 2023	January 2023	Preliminary lab report	10 business days after sample delivery
Data validation	Immediately on receipt of the Level IV data package	10 business days after receipt of the Level IV data package	Data Validation Report	10 business days after receipt of the Level IV data package
Summary Report	Two weeks after receipt of Data Validation Report	2 weeks after receipt of client comments	Summary Report	TBD

Notes:

AMSP Air Monitoring and Sampling Plan

GIS Geographic information system

TBD To be determined

7.0 FIELD ACTIVITIES AND PROCEDURES

This section outlines and provides rationale for the proposed field investigation activities, as well as procedures for sampling and data collection. As described in Section 2.0, the primary goal of the air monitoring and sampling activities is to evaluate the potential threat to human health caused by exposure to elevated concentrations of organic vapors, particulate matter, and other chemical contaminants in air. The primary goal of the water sampling activities is to characterize the fire suppression runoff and potential impacts to nearby surface water bodies.

7.1 METEOROLOGICAL MONITORING

Meteorological data for the site will be obtained continuously from the closest National Weather Service station. The data obtained will include:

- Temperature (°F)
- Relative humidity
- Wind direction
- Wind speed
- Current weather conditions (such as partly cloudy or raining)

7.2 AIR MONITORING

START will have a roaming team who will be collecting monitoring information at fifteen discrete locations and four stationary monitoring locations that are subject to change based on fire conditions, as well as true roaming monitoring readings collected throughout the site area of interest.

7.2.1 Roaming Air Monitoring Locations

START will utilize a team to conduct air monitoring on a designated route. These locations are subject to change based on fire conditions, wind direction, and other plume modelling criteria. In addition to the transect and sensitive receptor locations, START may establish upwind and downwind locations that change with changing wind conditions. The sensitive receptor locations include three schools and one assisted living facility. Additional roaming monitoring may be performed throughout the site area of interest based on site conditions and direction from EPA.

START will utilize a MultiRAE Pro, a handheld TSI DustTrak DRX particulate monitor (HDRX), and a SPM Flex at roaming air monitoring locations. An iPad will be used to collect air monitoring data on a Survey123 form for each roaming point for near real time updates on air quality. All readings will be collected at approximately 4.5 feet above the ground in the typical breathing zone of personnel. START will conduct air monitoring in accordance with Tetra Tech SOP No. 073-2, “Air Quality Monitoring” (Appendix B).

The MultiRAE Pro unit will be used to assess airborne concentrations of VOC, O₂, CO, H₂S, HCN, and the LEL. Each MultiRAE Pro unit contains a photoionization detector (PID) capable of monitoring for total VOC down to 10 parts per billion (ppb). The MultiRAE Pro unit also contains sensors to measure percent O₂, H₂S in parts per million (ppm), HCN in ppm, percent LEL, and CO in ppm. The MultiRAE Pro units will be calibrated according to the manufacturer's instructions to ensure precision and accuracy of the instrument response to standard.

The HDRX monitor is capable of monitoring for particulate concentrations down to 0.1 microgram per cubic meter (µg/m³). The HDRX will monitor for particulate matter with an aerodynamic diameter less than 1 microns (PM₁), PM_{2.5}, PM₄, PM₁₀, and total particulate matter. The HDRX monitors are factory calibrated and therefore do not require field calibration. However, the HDRX monitor monitors do require “zeroing” to ambient conditions, which will occur daily before use.

The SPM Flexes are capable of monitoring for several different compounds depending on the ChemCassette installed. START will select ChemCassettes based on direction from the OSC. Initially, START may utilize ChemCassettes for mineral acids, ammonia, fluorine, or chlorine.

START will periodically check the equipment to ensure it is operating properly and acquiring data.

7.2.2 Stationary Air Monitoring Locations

START will deploy a TSI DustTrak DRX particulate monitor (DustTrak) and a Honeywell RAE Systems AreaRAE Pro (AreaRAE Pro) at each air monitoring station. The DustTrak units will be used to assess airborne particulates. The AreaRAE Pro units will be used to assess airborne concentrations of VOC, O₂, CO, H₂S, and the LEL. Both instruments provide real-time readings for site-related contaminants.

START will place the AreaRAE Pro and DustTrak at approximately 4.5 feet above the ground in the typical breathing zone of personnel at each of the air monitoring stations. START will conduct air monitoring in accordance with Tetra Tech SOP No. 073-2, “Air Quality Monitoring” (Appendix B).

The DustTrak monitors are capable of monitoring for particulate concentrations down to 0.1 microgram per cubic meter (µg/m³). The DustTraks will monitor for particulate matter with an aerodynamic diameter less than 1 micron (PM₁), with an aerodynamic diameter less than 2.5 microns (PM_{2.5}), with an aerodynamic diameter less than 4 microns (PM₄, also known as respirable particulate matter), with an aerodynamic diameter less than 10 microns (PM₁₀, also known as thoracic particulate matter), and total particulate matter. Particulate monitors are factory calibrated and therefore do not require field calibration. However, particulate monitors do require “zeroing” to ambient conditions, which will occur daily before use.

Each AreaRAE Pro unit contains a PID capable of monitoring for total VOCs down to 0.01 ppm. The AreaRAE Pro unit also contains sensors to measure percent O₂, H₂S in ppm, percent LEL, and CO in ppm. The AreaRAE Pros will be calibrated according to the manufacturer's instructions to ensure precision and accuracy of the instrument response to standard.

START will periodically check the equipment to ensure it is operating properly and acquiring data. Real-time readings will be recorded on the device for download onto a computer twice a day, as well as through telemetry.

START will utilize telemetry to obtain real-time data and develop a web-viewer for off-site data review and visualization. Software used for telemetry will include EPA’s VIPER system, Safe Environment Engineering Lincs and Gateways, and Honeywell RAE Systems’ ProRAE Guardian system, in which strategically placed relays will communicate real-time results to a remote host computer throughout response activities. Data irregularities and problems will be identified and investigated.

TABLE 3: ACTION LEVELS
PROPOSED ACTION LEVELS BASED ON DIRECT-READING INSTRUMENTS

Parameter	Site-Specific Action Levels	ACGIH TLV	NIOSH REL	OSHA PEL	NAAQS	Level D Action Level ¹	Level C Action Level ¹	Level B Action Level ¹
VOC	500 ppb	NA	NA	NA	NA	< 5 ppm	Any response above background to 5 ppm (sustained for 5 minutes)	> 5 to 500 ppm
LEL	NA	10%			NA	< 5%	≥ 5 to 10%	> 10% (evacuate)
O ₂	NA	< 19.5% and > 23.5%			NA	19.5 to 23.5%		< 19.5% or > 23.5%
CO	NA	25 ppm	35 ppm	50 ppm	9 ppm	< 25 ppm	None, use Level B	> 25 ppm
F ₂	10 ppb	0.1 ppm	0.1 ppm	0.1 ppm	NA	0.05 ppm	NA	NA
H ₂ S	0.1 ppm	1 ppm	10 ppm	20 ppm	NA	< 1 ppm	NA	> 15 ppm
Particulates	PM ₁₀ : 50 µg/m ³ PM _{2.5} : 25 µg/m ³	NA	NA	TWA 15 mg/m ³ (total) 5 mg/m ³ (respirable)	PM ₁₀ : 150 µg/m ³ (24 hours)	< 2.5 mg/m ³	> 2.5 mg/m ³	NA
HCl	20 ppb	2 ppm C	5 ppm C	5 ppm C	NA	2.5 ppm	NA	NA
HCN	1 ppm	NA	10 ppm	3 ppm	NA	< 0.5 ppm	NA	> 2 ppm
NH ₃	NA	25 ppm	25 ppm TWA 35 ppm STEL	50 ppm	NA	< 25 ppm	25 to 250 ppm	250 to 300 ppm

¹ PPE determination action levels based on approved Site-Specific Health and Safety Plan

Notes:

> greater than
 ≥ greater than or equal to
 < less than

% percent

µg/m³ microgram per cubic meter

mg/m³ milligrams per cubic meter

ACGIH American Conference of Governmental Industrial Hygienists

C Ceiling

CO Carbon Monoxide

F₂ Fluorine

H₂S Hydrogen Sulfide

HCl Hydrochloric acid

HCN Hydrogen Cyanide

LEL Lower explosive limit

NAAQS National Ambient Air Quality Standard

NIOSH National Institute of Occupational Health and Safety

NA Not applicable

NH₃ Ammonia

O₂ Oxygen

OSHA Occupational Safety and Health Administration

PEL Permissible exposure limit

PM₁₀ Particulate matter with an aerodynamic diameter less than 10 microns

PM_{2.5} Particulate matter with an aerodynamic diameter less than 2.5 microns

ppb Parts per billion

ppm Parts per million

REL Recommended exposure limit

STEL Short-term exposure limit

TLV Threshold limit value

TWA Time weighted average

VOC Volatile organic compounds

7.3 AIR SAMPLING

Air sampling is not planned but is included in this AMSP as a contingency measure. If tasked by EPA, START will collect ambient air samples for VOCs in accordance with EPA Environmental Response Team (ERT) SOP No. 2008, Revision 1.1, “General Air Sampling Guidelines” (Attachment 1). START will collect samples at locations selected by EPA; the exact location of the ambient air samples will be determined in the field based on weather conditions and a visual inspection of the area.

Ambient air samples that will be submitted for VOCs will be collected using individually-certified stainless steel 6-liter SUMMA canisters, attached to 24-hour flow controllers, in accordance with EPA Scientific, Engineering, Response, and Analytical Services (SERAS) SOP No. 1704 Revision 01, “SUMMA Canister Sampling” (Attachment 1). SUMMA canisters will be placed at approximately 4.5 feet above the ground to represent the typical breathing zone. Once the SUMMA canister is in the appropriate sampling location, the canister valve will be opened, and the initial vacuum and start time will be recorded on a sampling data form. After approximately 24 hours, the canister valve will be closed and the end time and ending vacuum will be recorded. Before the SUMMA canister is closed at the end of the 24-hour sampling period, the SUMMA canister will be checked with a vacuum gauge to make certain that a vacuum still exists inside the canister.

Ambient air samples collected for VOCs will be submitted to ALS Simi Valley laboratory for analysis via EPA Method TO-15 SIM (EPA 1999). Ambient air sample results will be compared to EPA RSLs for Resident Ambient Air with a Target Cancer Risk of 1E-06 and a Hazard Quotient of 1 (EPA 2022a).

7.4 WATER QUALITY MONITORING

Water quality monitoring is not planned but is included in this AMSP as a contingency measure. If tasked by EPA, START will conduct water quality monitoring in surface water bodies as requested by EPA. Water quality monitoring will be conducted in accordance with EPA ERT SOP No. 2041-21, “Operation of Water Quality Multi-Parameters” (Attachment 1). START will utilize a Horiba U-52 multi-probe water quality monitor or similar to collect real-time measurements of dissolved oxygen (DO), pH, oxidation-reduction potential (ORP), specific conductivity, and turbidity. Measurements will be recorded in the field logbook or in Survey123 forms. Monitoring locations will be determined based on wind direction, the surface water flow path, and visual observations.

7.5 SURFACE WATER SAMPLING

Surface water sampling is not planned but is included in this AMSP as a contingency measure. If tasked by EPA, START will collect samples of fire suppression run-off water or of surface water potentially impacted by run-off for VOCs, SVOCs, pesticides/herbicides, and metals in accordance with Tetra Tech SOP No.

009-5, “Surface Water Sampling” (Appendix B). Due to the evolving and unpredictable of the response, samplers will adhere to sampling protocol to the extent possible; any deviations from the sampling protocol will be recorded in the field logbook.

The samples will be collected by filling a disposable container with water from the sampling location, and then decanting the water into the appropriate laboratory-provided containers. The disposable container may be dipped into the water with a gloved hand if it is safely accessible. Samples will be immediately placed in a cooler on ice and submitted under chain-of-custody for laboratory analysis. Surface water samples collected for metals, pesticides and herbicides, SVOC, and VOC will be submitted to ALS Holland for analysis via SW-846 Methods 6010/7470, 8081/8151, 8270, and 8260, respectively. Sample results will be compared to the IEPA Derived Water Quality Criteria List (IEPA 2019).

TABLE 4: SAMPLE SUMMARY

Matrix	Analytical Parameter	Analytical Method	Number of Samples	Number of Field Duplicates	Number of MS/MSDs	Number of Blanks	Total Number of Samples to Laboratory
Air	VOCs	TO-15 SIM	TBD	TBD	0	0	TBD
Water	Metals	SW-846: 6010 and 7470	TBD	TBD	TBD	0	TBD
Water	SVOCs	SW-846: 8270	TBD	TBD	TBD	0	TBD
Water	Pesticides/Herbicides	SW-846: 8081/8151	TBD	TBD	TBD	0	TBD
Water	VOCs	SW-846: 8260	TBD	TBD	TBD	TBD	TBD

Notes:

MS/MSD Matrix spike/matrix spike duplicate
 NA Not applicable
 SVOC Semivolatile Organic Compounds
 TBD To be determined
 VOCs Volatile organic compounds

7.6 FIELD DATA COLLECTION IN SUPPORT OF SAMPLING

During the sampling event described in this AMSP, START will document the site conditions using written and photographic methods. This documentation will consist of written descriptions of all response activities, including field conditions, observations, site activities, monitoring results, and sample descriptions in accordance with Tetra Tech SOP No. 024-3, “Recording Notes in Field Logbooks” (Appendix B).

8.0 DECONTAMINATION PROCEDURES

Disposable sampling equipment and personal protective equipment (PPE) will be double-bagged and disposed of with all other used PPE waste produced at the site. Reused sampling equipment will be

decontaminated between uses in accordance with Tetra Tech SOP No. 002-5, “General Equipment Decontamination” (Appendix B).

9.0 SAMPLE HANDLING

Each air sample will be labeled to identify the air monitoring station. Each surface water sample will be labeled to identify the sampling location. The samples will be labeled with the site ID (LaSalle Chemical Fire [LCF]), sample media (ambient air or surface water), air monitoring station number or runoff sample location number, sampling date (YYMMDD), and a QC sample type identifier (duplicate [-D] or field blank [-FB]), if applicable. Samples will be identified by a unique sample identification number, as described in Table 5 below.

TABLE 5: SAMPLE NOMENCLATURE

Site	Sample Media	Sample Location	Date	QC Sample Type (if applicable)	Example Identification
LCF	Ambient Air (AA)	Air Monitoring Station Number (ex: 01)	January 11, 2023	Duplicate samples (-D)	LCF-AA-01-230111
LCF	Surface Water (SW)	Sample Location Number (ex: SW01)	January 11, 2023	Duplicate samples (-D) or Field Blank (-FB)	LCF-SW-01-230111

Sampling locations will be noted in the site logbook and using Field Maps or similar application in accordance with Tetra Tech SOP No. 024-3, “Recording Notes in Field Logbooks” (Appendix B). The samples collected will be labeled, packaged, and shipped in accordance with procedures outlined in Worksheets #26 and 27 of the START Quality Assurance Project Plan (QAPP) (Tetra Tech 2022) and Tetra Tech SOP No.019-8, “Packaging and Shipping Samples” (Appendix B).

10.0 DISPOSAL OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) will consist of disposable nitrile gloves, paper towels, resealable plastic bags, and plastic trash bags. IDW will be double bagged and disposed of as dry industrial waste in accordance with the EPA Office of Emergency and Remedial Response (OERR) SOP, Management of Investigation-Derived Waste during Site Inspections (EPA 1991).

11.0 QUALITY ASSURANCE/QUALITY CONTROL

This section describes the quality assurance/quality control (QA/QC) procedures for the activities at the site. Specifically, this section addresses responsibilities, sample QC procedures, field QC procedures, and data evaluation and management.

11.1 RESPONSIBILITIES

QA/QC requirements will be adapted to project-specific conditions. The START project manager, Ms. Alexis Enright, will be responsible for ensuring that sample quality and integrity are maintained, and that sample labeling and documentation procedures are conducted in accordance with the START QAPP and this AMSP. When laboratory results are received, START will review the laboratory data packages for completeness and will conduct Level IV data validation in accordance with the START QAPP (Tetra Tech 2022).

All QA/QC activities will be conducted in accordance with this AMSP. A copy of this AMSP will be maintained by the field sampling team for immediate reference in resolving any QA/QC issues that might arise during field activities.

11.2 SAMPLE QUALITY CONTROL

Quality control (QC) samples will be collected to evaluate the field sampling and decontamination methods, and the overall reproducibility of the laboratory analytical results. Specifically, QC samples will be collected at the following frequencies:

- Field duplicate: 1 per 10 investigative samples
- Field blank: 1 per event (when applicable) or as specified in the analytical method

START chemists will validate the laboratory results in accordance with the START QAPP (Tetra Tech 2022). Corrective actions may include resampling, reassessment of the laboratory's methods, or assignment of data qualifiers to the laboratory results. The findings of the validation will be summarized in a data validation report, as stated in Section 6.0.

11.3 FIELD QUALITY CONTROL

Field QC measures will consist of adherence to proper sampling procedures in accordance with EPA ERT SOP No. 2008, Revision 1.1, "General Air Sampling Guidelines", SERAS SOP No. 1704 Revision 01, "SUMMA Canister Sampling" (Attachment 1), and Tetra Tech SOP No. 009-5, "Surface Water Sampling" (Appendix B). Samples will be shipped in accordance with Tetra Tech SOP No. 019-8, "Packaging and Shipping Samples" (Appendix B), and sampling activities will be documented in the site logbook and Survey123 or similar application as described in the START QAPP (Tetra Tech 2022) and Tetra Tech SOP No. 024-3, "Recording Notes in Field Logbooks" (Appendix B). All direct-reading instruments will be calibrated daily before use and according to manufacturer instructions.

11.4 DATA EVALUATION AND MANAGEMENT

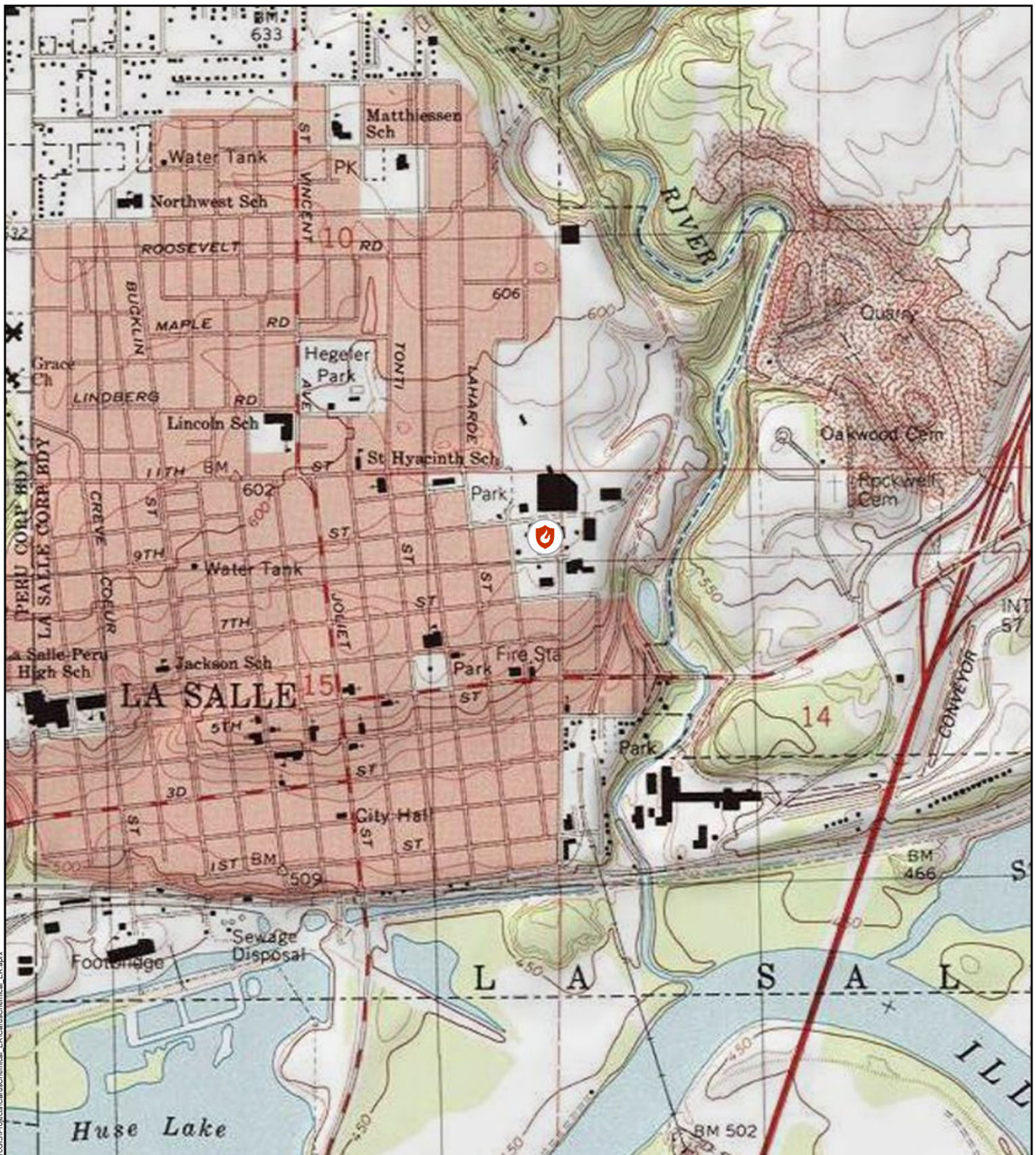
Digital data collected during site activities will be subject to routine QA/QC checks. These QA/QC checks will be performed daily, at a minimum, and will be implemented any time data are transitioned from one operating platform to another. For example, data entered on a tablet computer will be subject to a QA/QC check when they are downloaded from Survey123 or a similar application. The same data will then be subject to a QA/QC check when they are uploaded to the central project Scribe database, and a final QA/QC check will be performed as the central project Scribe database is populated with analytical results. The Scribe database will be published to Scribe.net to ensure data accessibility.

12.0 REFERENCES

- Illinois Environmental Protection Agency (IEPA). 2019. “Derived Water Quality Criteria List” November. Retrieved January 11, 2023, from <https://www2.illinois.gov/epa/topics/water-quality/standards/Pages/derived-criteria.aspx>
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APPENDIX A: FIGURES

1. Site Location Map
2. Site Layout Map



Site Location



Legend



Fire Location



Carus Chemicals Fire
LaSalle, LaSalle County,
Illinois

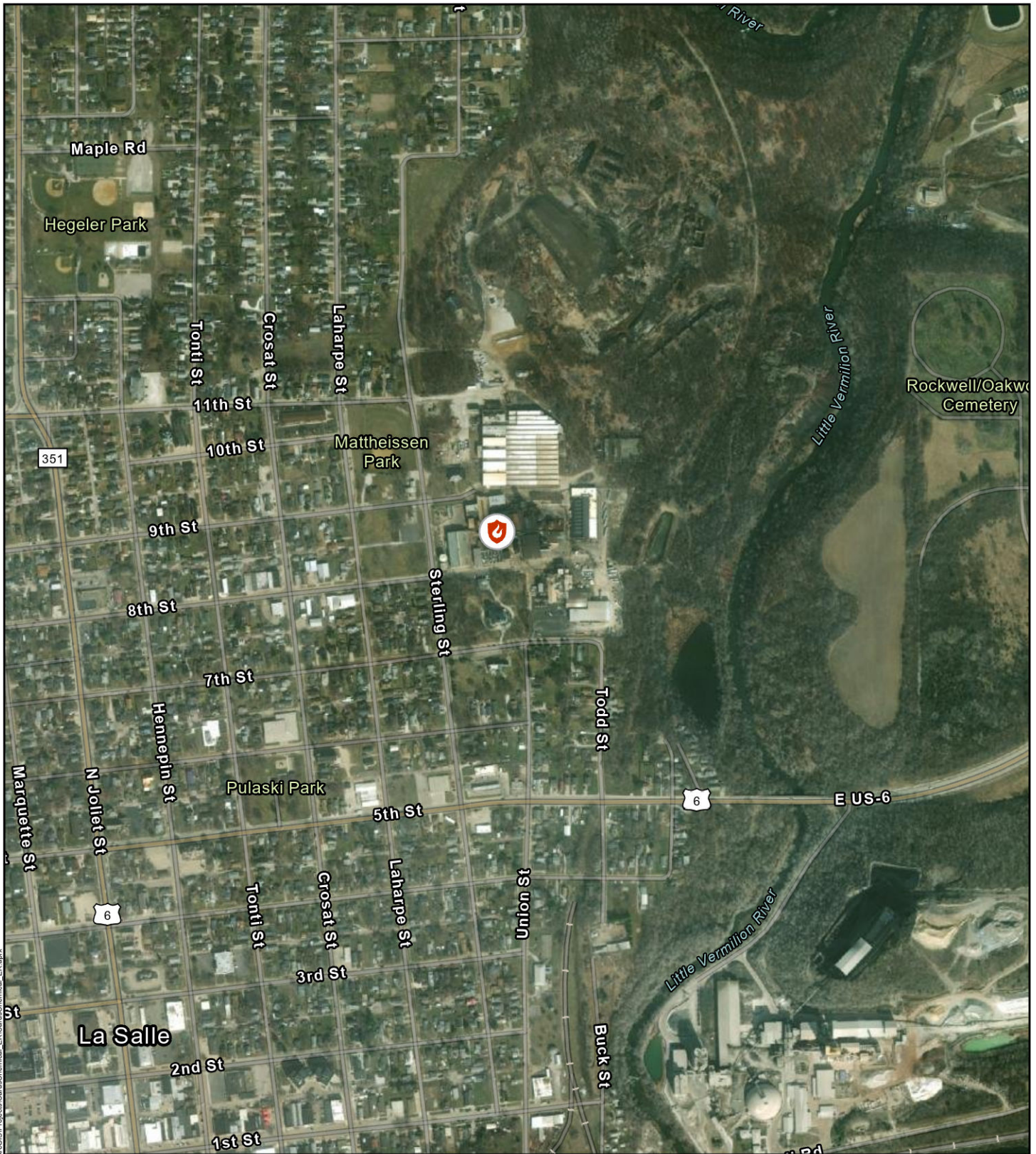
Figure 1
Site Location Map



TETRA TECH

Prepared For: EPA

Prepared By: Tetra Tech Inc.



Site Location



Legend



Fire Location



0 500 1,000
Feet

Carus Chemicals Fire
LaSalle, LaSalle County,
Illinois

Figure 2
Site Layout Map



TETRA TECH

APPENDIX B: STANDARD OPERATING PROCEDURES

1. SOP 002-5 (General Equipment Decontamination)
2. SOP 009-5 (Surface Water Sampling)
3. SOP 019-8 (Packaging and Shipping Samples)
4. SOP 024-3 (Recording of Notes in Field Logbook)
5. SOP 073-2 (Air Quality Monitoring)

SOP APPROVAL FORM

TETRA TECH, INC.

EMI OPERATING UNIT

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GENERAL EQUIPMENT DECONTAMINATION

SOP NO. 002

REVISION NO. 5

Last Reviewed: August 2021



Quality Assurance Approved

August 2021

Date

1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. All sampling equipment must be thoroughly cleaned before each use to prevent contamination of samples.

1.3 DEFINITIONS

Alconox: Phosphate-containing soap, obtained in powder form and dissolved in water

Deionized (DI) Water: DI water is water that has been treated to remove all ions – typically, that means all of the dissolved mineral salts and metal ions.

Liquinox: Phosphate-free soap, obtained in liquid form for mixing with water

Luminox: Specialized detergent with the capability of removing oils and organic contamination, also phosphate-free and liquid

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992. “RCRA Ground-Water Monitoring: Draft Technical Guidance.” Office of Solid Waste. Washington, DC. EPA/530 R 93 001. November.

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1.5 REQUIREMENTS AND RESOURCES

The equipment and supplies to conduct decontamination may include the following:

- Scrub brushes

- Large wash tubs or buckets
- Squirt or spray bottles
- Alconox or Liquinox (Note: Alconox contains phosphates, and phosphates have been banned in many household cleaning products based on their adverse effect on the environment.)
- Tap water
- Distilled water
- DI water
- Plastic sheeting
- Aluminum foil
- Isopropanol (laboratory grade) or Luminol

2.0 PROCEDURES

This section describes procedures for decontamination of personal protective equipment (PPE) as well as equipment for drilling and monitoring well installation, borehole soil sampling, general sampling, water level measurement, and groundwater sampling. PPE (as outlined in the site-specific health and safety plan) should be used during decontamination procedures. Special handling of used PPE and wastewater generated from decontamination procedures may be required if the type of contamination is considered hazardous according to the Resource Conservation and Recovery Act (RCRA).

Any special handling should also be outlined in the site-specific health and safety plan or the sampling and analysis plan. At a minimum, no eating, drinking, smoking, or any other hand-to-mouth contact should be allowed during decontamination activities.

Some clients may have additional requirements for decontamination procedures. For example, phosphate-free detergent may be a requirement and, therefore, it would not be appropriate to use Alconox.

Source water for decontamination should be selected based on site-specific conditions and contaminants. In general, laboratory DI water is preferred for decontamination of instruments and sampling devices. Standard distilled water, readily available at grocery stores, may be appropriate at other times. However, distilled water may still contain unacceptable levels of inorganic ions. Decontamination of heavy equipment such as drill rigs will typically use tap water or similar source water, often used in combination with a steam or hot-water cleaning unit. During procurement, Tetra Tech personnel should specify the source of decontamination water to be used by the subcontractors and ensure that it is consistent with investigation goals. Refer to the site-specific sampling and analysis plan for details concerning source water.

In general, conduct field activities to move from cleaner to more contaminated locations to minimize the potential for cross contamination between locations.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off site or to clean areas. Refer to the site-specific health and safety plan as the first resource for types of PPE; not all types of PPE nor methods for decontamination discussed below will be appropriate for every site. All used disposable protective clothing, such as Tyvek, coveralls, gloves, and booties, will be containerized for later disposal.

Decontamination water will be containerized in 55-gallon drums or similar sealable containers (refer to Section 3.0).

Personnel decontamination procedures will be as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.
3. Remove outer gloves and place into plastic bag for disposal.
4. Remove Tyvek or coveralls. Containerize Tyvek for disposal and place coveralls in plastic bag for laundry before reuse.
5. Remove air purifying respirator (APR), if used, and place the spent filters in a plastic bag for disposal. Filters should be changed daily or sooner, depending on use and application. Place the respirator into a separate plastic bag after it has been cleaned and disinfected according to the instructions for the respirator.
6. Remove disposable gloves and place them in plastic bag for disposal.
7. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated at a designated location on site before drilling operations begin, between borings, and at completion of the project. Decontamination may be conducted on a temporary decontamination pad constructed at a satellite location within the site. The purpose of the decontamination pad is to contain wash waters and potentially contaminated soil generated during decontamination procedures. Decontamination pads may be constructed of concrete, wood, or plastic sheeting, depending on the site-specific needs and plans. Wash waters and contaminated soil generated during decontamination should be considered investigation-derived waste (IDW) and, thus, should be collected and containerized for proper disposal.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they may be steam cleaned and placed on polyethylene sheeting on site before they are used downhole, if required by the site-specific work plan. The drilling subcontractor will typically furnish the steam cleaner and water.

The drilling auger, bits, drill pipe, any portion of drill rig that is over the borehole, temporary casing, surface casing, and other equipment used in or near the borehole should be decontaminated by the drilling subcontractor as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Remove loose soil using shovels, scrapers, wire brushes, and any related material.
3. Steam clean or pressure wash to remove all visible dirt. Use appropriate PPE (for example, a face shield and Tyvek/coveralls) as necessary.
4. If equipment has directly or indirectly contacted contaminated media and is known or suspected of being contaminated with oil, grease, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), or other hard-to-remove organic materials, rinse equipment with laboratory-grade isopropanol or Luminol solution.
5. To the extent possible, allow components to air dry; drying helps limit the spread of contamination through contact. Equipment should be dried and stored upwind of contaminated areas to minimize potential cross-contamination.
6. All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING DOWNHOLE EQUIPMENT DECONTAMINATION AND GENERAL SOIL SAMPLING EQUIPMENT DECONTAMINATION

All soil sampling equipment should be decontaminated before use and after each sample as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Scrub the split-barrel sampler and sampling tools in a wash bucket or tub using a stiff, long-bristle brush with a solution of tap water with Liquinox or Alconox.
3. Rinse equipment thoroughly with tap water or distilled water.
4. Perform a final rinse with DI or distilled water. Refer to the site-specific sampling and analysis plan for requirements for DI or distilled water.
5. Place cleaned equipment in a clean area on plastic sheeting or aluminum foil and allow to air-dry. Clean, dry equipment should be stored in clean equipment cases to minimize potential cross-contamination. If the equipment does not have a case, it should be stored on a clean surface upwind of contaminated areas to minimize potential cross-contamination.
6. Containerize all water and rinsate; also, containerize disposable, single-use sampling equipment.

2.4 WATER LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the water-level indicator or interface probe before inserting and after removing it from each well. The following decontamination procedures should be used:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Wipe the tape and probe with a disposable Alconox- or Liquinox-impregnated cloth or paper towel. Spray the probe with Alconox or Liquinox solution to ensure that all ports on the probe are cleaned.
3. If immiscible layers are encountered, the interface probe may require steam cleaning or washing with laboratory-grade isopropanol or Luminox solution.
4. Rinse with distilled or deionized water, including spraying the probe with rinse water.
5. Store clean, dry equipment in clean equipment cases to minimize potential cross-contamination. If the equipment does not have a case, it should be stored on a clean surface upwind of contaminated areas to minimize potential cross-contamination.
6. Containerize all water and rinsate for proper disposal.

2.5 GROUNDWATER SAMPLING EQUIPMENT

The following procedures are to be employed to decontaminate equipment used for groundwater sampling. Decontamination is not necessary when using disposable (single-use) or dedicated (reused but only at a single sample point) pump tubing or bailers. Decontamination procedures for reused equipment are described below.

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Remove and containerize any purge water in the pump and tubing and dispose of tubing.
3. Dismantle the pump as much as possible and scrub components in a wash bucket or tub using a stiff brushes of appropriate size with a solution of tap water with Liquinox or Alconox.
4. Rinse pump components thoroughly with tap water or distilled water.
5. If groundwater contains or is suspected to contain oil, grease, PAHs, PCBs, or other hard-to-remove organic materials, rinse the pump and tubing with laboratory-grade isopropanol or Luminox solution.
6. Perform a final rinse with DI or distilled water.
7. Allow components to air dry.
8. Wrap pump in aluminum foil or a clean plastic bag for storage.
9. Containerize the used tubing and decontamination wash waters for proper disposal.

3.0 INVESTIGATION-DERIVED WASTE

IDW can include disposable, single-use PPE and sampling equipment, soil cuttings, purge water, and decontamination wash waters and sediments. Requirements for waste storage may differ from one facility to the next. Facility-specific directions for waste storage will be provided in project-specific documents, or separate direction will be provided by the project manager. Make sure to consult with a qualified professional before making any waste characterization decisions. The following guidelines are provided for general use:

1. Assume that all IDW generated from decontamination contains the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. Waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.
2. Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility.
3. Label IDW storage containers with the facility name and address, date, contents, company generating the waste, and an emergency contact name and phone number.
4. Temporarily store the IDW in a protected area that provides access to the containers and allows for spill/leak monitoring, sampling of containers, and removal after the disposal method has been identified.

SOP APPROVAL FORM

TETRA TECH, INC.

EMI OPERATING UNIT

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

SURFACE WATER SAMPLING

SOP NO. 009

REVISION NO. 5

Last Reviewed: March 2020



Quality Assurance Approved

March 2020

Date

1.0 BACKGROUND

Surface water sampling is conducted to measure the quality of surface water entering, leaving, or affected by a site. Surface water bodies that can be sampled include streams, rivers, lakes, ponds, lagoons, and surface impoundments. This standard operating procedure (SOP) discusses common methods of collecting grab samples that represent water quality in a water body at a particular point in time.

A series of grab samples also can be composited to represent water quality over a longer period of time. Composite samples can be flow proportional or time proportional. The details of compositing water samples are not included in this SOP.

1.1 PURPOSE

This SOP establishes the requirements and procedures for surface water sampling.

1.2 SCOPE

This SOP applies to surface water sampling and the instruments and methods used to collect the samples.

1.3 DEFINITIONS

Kemmerer Sampler: A messenger-activated water sampling device. Water flows through the device until the release mechanism is triggered to close the container (see Figure 1).

Peristaltic Pump: A rotary, positive-displacement pumping device characterized by its low suction and rhythmic operation, and by the fact that the pump does not come into direct contact with the water being sampled (see Figure 2).

Pond Sampler: A sampling device fabricated by using an adjustable beaker clamp to attach a beaker to a telescoping, heavy-duty aluminum pole (see Figure 3).

1.4 REFERENCES

- U.S. Environmental Protection Agency (EPA). 1977. "Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities." EPA-530/SW-611. August.
- EPA. 1980. "Samplers and Sampling Procedures for Hazardous Waste Streams." EPA-600/2-80-018. January.
- EPA. 1984. "Characterization of Hazardous Waste Sites — A Methods Manual, Volume II. Available Sampling Methods." Second Edition. EPA 600/4 84 076. December.

EPA. 1994. “Surface Water Sampling.” Environmental Response Team SOP #2013 (Rev. #0.0, 11/17/94). On-Line Address: http://204.46.140.12/media_resrcs/media_resrcs.asp?Child1

EPA. 2016. “Operating Procedure – Surface Water Sampling.” Science and Ecosystem Support Division. SESDPROC-201-R4. December.

1.5 REQUIREMENTS AND RESOURCES

Surface water sampling requires a variety of procedures and instruments. The choice of procedure should be determined by site-specific conditions, such as the type of surface water body, the sampling depth, and the distance of the sample location from shore.

Samples can be collected from shallow depths by submerging the sample container. An intermediary disposable collection container or one constructed of a nonreactive material also may be used. A pond sampler, a peristaltic pump, or a Kemmerer sampler may be used to provide extended reach. The following equipment may be required to sample surface water:

- Decontamination materials
- Sample containers and labels
- Point-source bailer
- Dipper
- Boat
- Pond sampler
- Peristaltic pump with batteries or power source
- Silicone tubing
- Heavy-wall Teflon tubing
- Kemmerer sampler
- Bucket
- Logbook or field data sheets
- Chain-of-custody documentation
- Shipping materials
- Automatic sampler
- Pond sampler
- Disposable gloves
- Waders or gum boots
- Personal floatation devices, tethers, or other health and safety equipment required for working on or near water

2.0 PROCEDURES

Safe access, handling, and other physical limitations should be influential factors during surface water sampling. A site-specific sampling plan should delineate which of the procedures described below will be used. Any deviations from the sampling plan should be recorded in the site-specific field logbook.

The following subsections provide detailed procedures for surface water sampling using specific instruments and methods. In all cases, select a sampling location where the water quality will best represent the water chemistry of the water body. Avoid stagnant or fast-moving areas. Do not sample immediately downstream of incoming tributaries, because of the likelihood of incomplete mixing. Ensure that the field sampling team is familiar with all health and safety procedures required for working on or near water.

2.1 EQUIPMENT CALIBRATION

Prior to sample collection, the monitoring equipment used to measure pH, Eh, dissolved oxygen (DO), turbidity, and specific conductance (SC) should be calibrated or checked according to manufacturer's directions. Typically, calibration activities are completed at the field office before beginning sampling activities each day. The pH meter calibration should bracket the expected pH range of the water to be sampled (acidic to neutral pH range [4.00 to 7.00] or neutral to basic pH range [7.00 to 10.00]). The DO meter should be calibrated to one point (air-saturated water) or two points (air-saturated water and water devoid of all oxygen). SC meters and turbidity meters typically cannot be calibrated by end users, but their accuracy can be checked against a known standard. The offset of the measured value of the calibration standard can be used as a correction value. Similarly, the Eh probe cannot be calibrated but is checked against a known standard, such as Zobell solution. The instrument should display a millivolt (mV) value that falls within the range set by the manufacturer. Because Eh is temperature dependent, the measured value should be corrected for site-specific variance from standard temperature (25 °C). The Eh probe should be replaced if the reading is not within the manufacturer's specified range.

2.2 SURFACE WATER SAMPLING BY SUBMERGING SAMPLE CONTAINER

Barring other considerations like physical access limitations or cross-contamination by contact of the outside of the container with the water body, direct collection by submerging the sample container is the preferred method for collecting a surface water sample, when possible.

Samples from shallow depths should be collected by submerging the sample container. This method is advantageous when the sample might be significantly altered during transfer from a collection vessel into another container. This method should not be used for sampling lagoons or surface impoundments where

contact with contaminants is a potential concern or if sampling for volatile organic compounds (VOC) or other analytical parameters requiring pre-preserved sample containers. The use of a transfer device or container is described in the following section.

The following procedure can be used for sampling surface water by submerging the sample container:

1. Place all equipment on plastic sheeting next to the sampling location. Sample containers should be selected in accordance with the requirements specified in the project-specific field work plan, field sampling plan, or quality assurance project plan (QAPP).
2. If required by the project, measure field parameters (such as temperature and pH) using procedures in relevant specific Tetra Tech SOPs and project-specific field sampling plans. Record this information on the field data sheet or in the logbook.
3. A visual check for visible surface material (pond scum or ice) should be performed before sampling. If present, surface water samples should be collected by directly submerging the sample container (with lid still on) into the surface water at the specified sampling location. Avoid contacting the bottom of the water body with the sample container because this will disturb sediment that may interfere with the surface water sample. Once submerged, the lid should be removed to allow the container to fill with water below any visible material on the surface of the water. A visual check should be conducted during and after sample collection to ensure sample integrity. If no surface materials are present, sample as instructed below.
4. For stream sampling, sample the location farthest downstream first. In general, work from zones suspected of low contamination to zones of high contamination. Orient the mouth of the sample container facing upstream while standing downstream so as not to stir up any sediment that would contaminate the sample. Avoid contacting the bottom of the water body with the sample container because this will disturb sediment that may interfere with the surface water sample.
5. For a larger body of surface water, such as a lake, collect samples near the shore, unless boats are feasible and permitted. Collect samples from shallow depths by submerging the sample container. Avoid contacting the bottom of the water body with the sample container because this will disturb sediment that may interfere with the surface water sample. If sampling from a boat, collect the sample as far away as possible from the outboard engine to avoid possible fuel contamination.
6. If sediment samples are to be collected (using procedures in SOP No. 006 [Sludge and Sediment Sampling]) with surface water samples, collect surface water samples at each location before collecting sediment samples to avoid contaminating the water samples with excess suspended particles generated during sediment sampling.
7. Allow the water to fill the container until it is almost full.
8. Add preservative to the sample in accordance with requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Secure the cap tightly and affix a completed sample label to the container.
9. Complete all chain-of-custody documentation, field logbook entries, and sample packaging requirements.

2.3 SURFACE WATER SAMPLING WITH TRANSFER DEVICE

A transfer device can be used in most sampling situations and is preferred when (1) direct contact or physical access limitations pose a health and safety concern or (2) sample containers are pre-preserved. A dipper, bailer, or other device made of inert material, such as stainless steel or Teflon, can be used to transfer liquid samples from their source to a sample container. A clean, empty, unpreserved sample container may also be used following this method.

Use of a transfer device prevents contamination of the outside of the sample container as a result of direct immersion in surface water. Depending on the sampling application, the transfer device may be either disposed of or reused. If reused, the device should be thoroughly rinsed and decontaminated in accordance with SOP No. 002 (General Equipment Decontamination), prior to sampling a different source.

The following procedure can be used for sampling surface water with a dipper, bailer, or other transfer device:

1. Place all equipment on plastic sheeting next to the sampling location. Sample containers should be selected in accordance with the requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Ensure that the transfer device was decontaminated after its last use.
2. If required by the project, measure field parameters (such as temperature and pH) using procedures in relevant specific Tetra Tech SOPs and project-specific field sampling plans. Record this information on the field data sheet or in the logbook.
3. With minimal surface water disturbance, submerge a precleaned dipper, bailer, or other transfer device.
4. Allow the device to fill slowly and continuously.
5. Retrieve the device from the surface water with minimal disturbance.
6. Remove the cap from the sample container. Slightly tilt the mouth of the container below the edge of the transfer device.
7. Empty the device slowly, allowing the sample to flow gently down the inside of the container with minimal entry turbulence. Continue to fill the container until it is almost full. If sampling for VOCs, the container must be completely filled leaving no head space.
8. Preserve the sample in accordance with requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Secure the cap tightly and affix a completed sample label to the container.
9. Complete all chain-of-custody documentation, field logbook entries, and sample packaging requirements.

10. Decontaminate the transfer device prior to reuse or storage using the procedures in SOP No. 002 (General Equipment Decontamination).

2.4 SURFACE WATER SAMPLING WITH POND SAMPLER

A pond sampler may be used to collect liquid samples from manholes, ponds, pits, and lagoons (see Figure 3). A pond sampler is easily and inexpensively fabricated. To construct a pond sampler, use an adjustable clamp to attach a sampling beaker to the end of a two- or three-piece telescoping aluminum tube. The telescoping tube serves as the handle. All reused equipment should be cleaned after each use.

The following procedure can be used for sampling surface water with a pond sampler:

1. Place all equipment on plastic sheeting next to the sampling location. Sample containers should be selected in accordance with the requirements specified in the project-specific field work plan, field sampling plan, or QAPP.
2. If required by the project, measure field parameters (such as temperature and pH) using procedures in relevant specific Tetra Tech SOPs and project-specific field sampling plans. Record this information on the field data sheet or in the logbook.
3. Assemble the pond sampler. Ensure that the sampling beaker, bolts, and nuts securing the clamp to the pole are tightened properly and that the equipment was decontaminated after its last use.
4. Collect the sample by slowly submerging the precleaned beaker with minimal surface water disturbance.
5. Retrieve the pond sampler from the surface water with minimal disturbance.
6. Remove the cap from the sample container. Slightly tilt the mouth of the container below the edge of the beaker.
7. Empty the beaker slowly, allowing the sample to flow gently down the inside of the container with minimal entry turbulence. Continue filling until the container is almost full. If sampling for VOCs, the container must be completely filled leaving no head space.
8. Preserve the sample in accordance with requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Secure the cap tightly and affix a completed sample label to the container.
9. Complete all chain-of-custody documentation, field logbook entries, and sample packaging requirements.
10. Decontaminate the pond sampler prior to reuse or storage using the procedures in SOP No. 002 (General Equipment Decontamination).

2.5 SURFACE WATER SAMPLING WITH PERISTALTIC PUMP

To extend reach in sampling efforts, a small peristaltic pump can be used (see Figure 2). A peristaltic pump draws the sample through heavy-wall Teflon tubing and pumps it directly into the sample container. Use of a peristaltic pump allows the operator to reach out into a liquid body, to sample from a depth or to

sweep the width of a narrow stream. A battery-powered pump is preferable because it eliminates the need for a direct current generator or an alternating current inverter.

If medical-grade silicone tubing is used in the peristaltic pump, it is suitable for sampling almost any parameter, including most organic compounds. However, some VOC stripping may occur and some sample material may adhere to the tubing. Teflon tubing may be used in place of silicone tubing on the intake side of the pump to minimize the amount of sample adherence to the tubing. In addition, the pumping action of the peristaltic pump may cause volatilization of some organic compounds. Use of the “soda straw” method described below will minimize volatilization loss. Finally, peristaltic pumps typically cannot lift water more than about 20 to 25 feet.

Procedures for sampling surface water with a peristaltic pump are as follows:

1. Place all equipment on plastic sheeting next to the sampling location. Sample containers should be selected in accordance with the requirements specified in the project-specific field work plan, field sampling plan, or QAPP.
2. If required by the project, measure field parameters (such as temperature and pH) using procedures in relevant specific Tetra Tech SOPs and project-specific field sampling plans. Record this information on the field data sheet or in the logbook.
3. Install clean, medical-grade silicone tubing in the pump head according to the manufacturer’s instructions. Allow enough tubing on the discharge side to facilitate delivery of liquid into the sample container. Allow only enough tubing on the suction end for attachment to the intake line. This will minimize sample contact with the tubing.
4. Select the length of intake tubing needed to reach the required sample location. Attach it to the intake side of the pump tubing. Heavy-wall Teflon tubing of a diameter equal to that of the required pump tubing suits most applications. A heavier tubing wall will allow slightly greater lateral reach.
5. If possible, allow several liters of surface water to pass through the pump before collecting the sample. Collect this purge volume. Return it to the source after the samples have been withdrawn.
6. Fill the sample container by allowing the pump discharge to flow gently down the inside of the bottle with minimal entry turbulence. Continue delivery of the sample until the container is almost full.
7. If sampling for VOCs, the VOC sample should be collected using one of the “soda straw” variations. Ideally, the tubing intake will be placed at the depth from which the sample is to be collected and the pump will be run for several minutes to fill the tubing with water representative of that interval. After several minutes, the pump is turned off and the tubing string is retrieved. The pump speed is then reduced to a slow pumping rate and the pump direction is reversed. After the pump is turned back on, the sample stream is collected into the VOC vials as it is pushed from the tubing by the pump. Care must be taken to prevent any water that was in contact with the peristaltic pump head tubing from being incorporated into the sample.

8. Preserve the sample in accordance with requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Secure the cap tightly and affix a completed sample label to the container.
9. Complete all chain-of-custody documentation, field logbook entries, and sample packaging requirements.
10. Allow the pump to drain, and then disassemble it. Dispose of any tubing that came into contact with the sample.

2.6 SURFACE WATER SAMPLING WITH KEMMERER SAMPLER

The Kemmerer sampler (see Figure 1) is used to collect surface water samples when the required sample depth is greater than that which can be sampled with a peristaltic pump (greater than about 25 feet).

A Kemmerer sampler may be constructed of various materials to be compatible with the required analytical technique. The sampler should be cleaned before and after each use.

Procedures for sampling surface water with a Kemmerer sampler are as follows:

1. Place all equipment on plastic sheeting next to the sampling location. Sample containers should be selected in accordance with the requirements in specified in the project-specific field work plan, field sampling plan, or QAPP.
2. If required by the project, measure field parameters (such as temperature and pH) using procedures in relevant specific Tetra Tech SOPs and project-specific field sampling plans. Record this information on the field data sheet or in the logbook.
3. Inspect the body of the Kemmerer sampler to ensure that the drain line valve is closed, as appropriate. Measure and mark the sample line (cable) at the desired sampling depth.
4. Open the sampler by lifting the upper stopper trip head assembly.
5. Gradually lower the sampler into the surface water until the sample liquid reaches the sample line.
6. Place a messenger on the sample line and release it, closing the sampler.
7. Retrieve the sampler. Prevent accidental opening of the lower stopper by holding the center rod of the sampler.
8. Rinse or wipe off the exterior of the sampler. Recover the sample by grasping the lower stopper and sampler body with one hand. Transfer the sample by lifting the upper stopper with the other hand and carefully pouring the contents into the sample container. If a drain line valve is present, hold the valve over the sample container, and open the valve slowly to release the sample.
9. Transfer the sample slowly, allowing it to flow gently down the inside of the container with minimal entry turbulence. Continue filling the container until it is almost full. If sampling for VOCs, the container must be completely filled leaving no head space.
10. Preserve the sample in accordance with requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Secure the cap tightly and affix a completed sample label to the container.

11. Complete all chain-of-custody documentation, field logbook entries, and sample packaging requirements.
12. Decontaminate the Kemmerer sampler prior to reuse or storage using the procedures in SOP No. 002 (General Equipment Decontamination).

2.7 SURFACE WATER SAMPLING WITH SUBMERSIBLE PUMPS

A submersible pump may be used when low-flow sampling is required. A submersible pump draws the sample through heavy-wall Teflon tubing using a frequency converter and pumps it directly into the sample container. If medical-grade silicone tubing is used, it is suitable for sampling almost any parameter, including most organic compounds. However, some VOC stripping may occur and some sample material may adhere to the tubing. Teflon tubing may be used in place of silicone tubing to minimize the amount of sample adherence to the tubing. The pump must be cleaned after each use following the procedures specified in SOP No. 002 (General Equipment Decontamination).

Procedures for sampling surface water with a submersible pump are as follows:

1. Place all equipment on plastic sheeting next to the sampling location. Sample containers should be selected in accordance with the requirements specified in the project-specific field work plan, field sampling plan, or QAPP.
2. If required by the project, measure field parameters (such as temperature and pH) using procedures in relevant specific Tetra Tech SOPs and project-specific field sampling plans. Record this information on the field data sheet or in the logbook.
3. Inspect the pump to confirm that it was decontaminated after any previous use.
4. Place the converter in the sampling area in a place where it will not come into contact with any water.
5. Connect clean tubing to the pump according to the manufacturer's instructions. Select the length of tubing needed to reach the required sample location.
6. Lower the pump to the sampling location, taking care not to damage the motor cable and ensuring that the pump is completely submerged before beginning sampling.
7. Keeping the pump completely submerged throughout sampling, connect to the converter according to the manufacturer's instructions. If possible, allow several liters of surface water to pass through the tubing before collecting the sample. Collect this purge volume. Return it to the source after the samples have been withdrawn.
8. Fill the sample container by allowing the pump discharge to flow gently down the inside of the bottle with minimal entry turbulence. Continue filling the container until it is almost full. If sampling for VOCs, the container must be completely filled leaving no head space.
9. Preserve the sample in accordance with requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Secure the cap tightly and affix a completed sample label to the container.

10. Complete all chain-of-custody documentation, field logbook entries, and sample packaging requirements.
11. Disassemble the pump and converter according to the manufacturer's instructions. Decontaminate the pump before reuse using the procedures in SOP No. 002 (General Equipment Decontamination). Dispose of any tubing that came into contact with the sample.

2.8 SURFACE WATER SAMPLING WITH BUCKET

A plastic bucket is used to collect surface water samples for measurement of water quality indicator parameters (such as pH, temperature, and conductivity) or water quality parameters (such as ammonia, nitrate-nitrite, phosphorus, and total organic carbon). This method is not recommended for collecting samples for VOC chemical analysis. This method may be acceptable for other chemical analyses; consult the project-specific field sampling plan. A bucket is commonly used to collect a sample when the water depth is too great for wading, it is not possible to deploy a boat, or access is restricted (excessive vegetation or steep embankments) and the water column is well mixed. The water body is usually accessed from a bridge. The bucket is lowered by rope over the side of the bridge and, upon retrieval, the water is poured into the appropriate sample containers.

2.9 AUTOMATIC SAMPLERS

Where unattended sampling is required (such as storm-event sampling or time-of-travel studies), an automatic sampler may be used. The automatic sampling device may be used to collect grab samples based on time, in-stream flow, or water level, or it may be used to collect composite samples as dictated by the project data needs. The automatic sampling device should be calibrated prior to deployment to insure the proper volume is collected. Site characteristics and project needs will determine placement and how to best secure the sampling device. Care should be taken to ensure the automatic sampler inlet tube is properly placed and secured in the water column to obtain a representative sample. The manufacturer's instruction manual should be consulted for automatic sampler operation.

FIGURE 1

KEMMERER SAMPLER

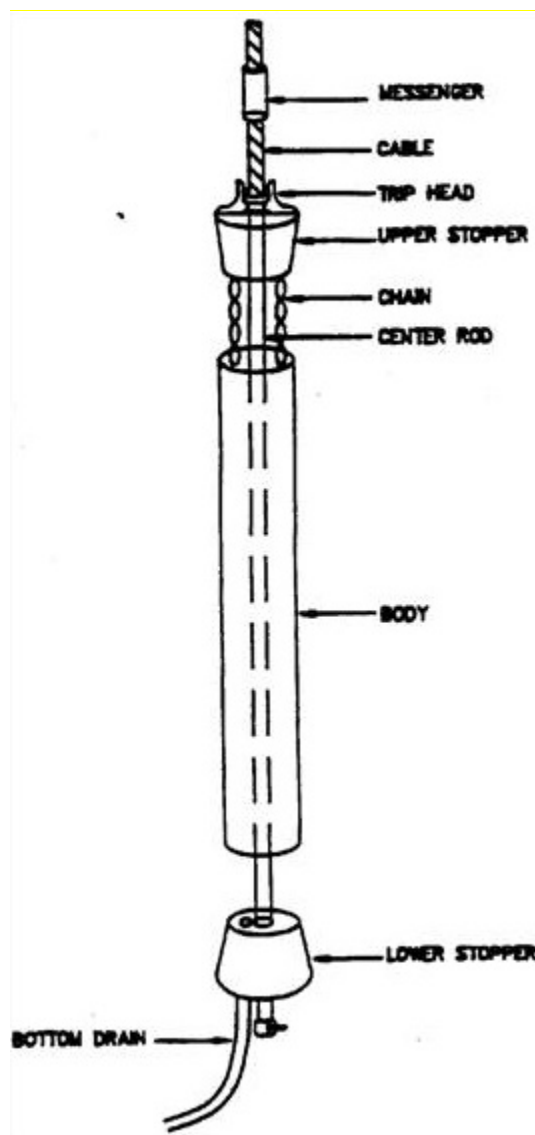


FIGURE 2

PERISTALTIC PUMP FOR LIQUID SAMPLING

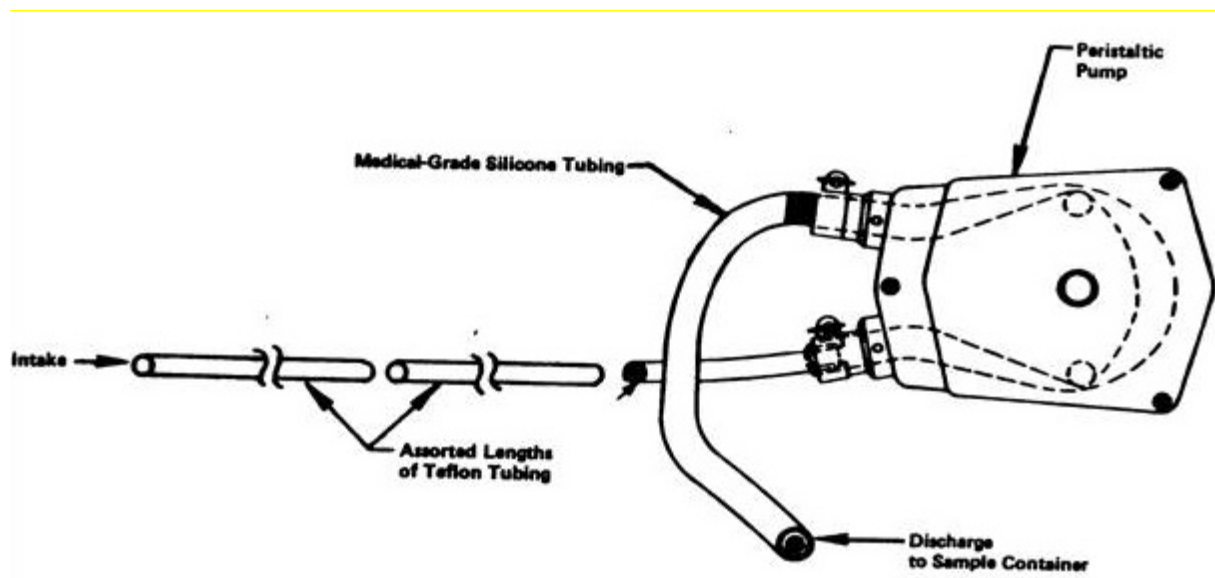
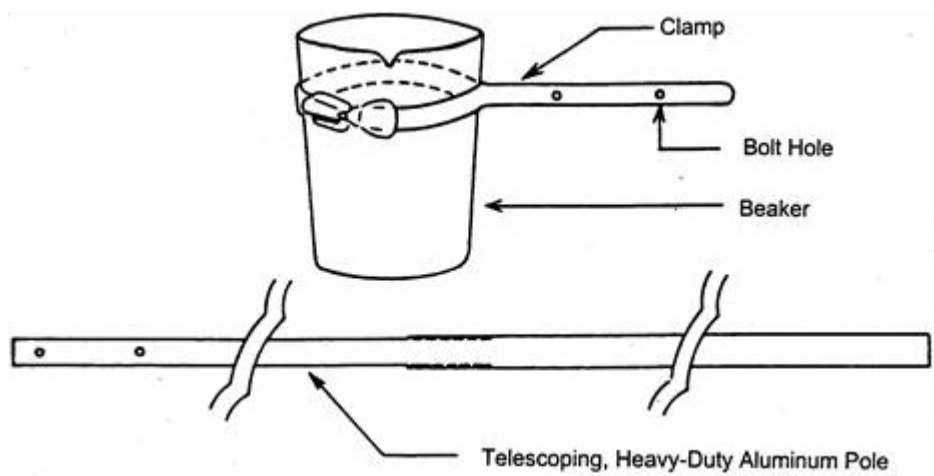


FIGURE 3

POND SAMPLER



SOP APPROVAL FORM

TETRA TECH, INC.

EMI OPERATING UNIT

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

PACKAGING AND SHIPPING SAMPLES

SOP NO. 019

REVISION NO. 8

Last Reviewed: August 2020



Quality Assurance Approved

August 11, 2020

Date

1.0 BACKGROUND

In any sampling program, the integrity of a sample must be ensured from its point of collection to its final disposition. This standard operating procedure (SOP) describes procedures for packaging and shipping samples. Steps in the procedures should be followed to ensure sample integrity and to protect the welfare of persons involved in shipping and receiving samples.

1.1 PURPOSE

This SOP establishes the requirements and procedures for packaging and shipping nonhazardous environmental samples. It has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) “Contract Laboratory Program Guidance for Field Samplers.” Procedures described in this SOP should be followed for all routine sample packaging and shipping of nonhazardous samples. If procedures are to be modified for particular contract- or laboratory-specific requirements, modified procedures should be clearly described in site-specific plans such as work plans, field sampling plans (FSP), or quality assurance project plans (QAPP). Deviations from the procedures in this SOP must be documented in a field logbook. This SOP assumes that samples are already in the appropriate sample jars and that the sample jars are labeled.

This SOP does not cover the packaging and shipment of Dangerous Goods or Hazardous Materials.

The shipment of Dangerous Goods (by air) and Hazardous Materials (by ground) requires specialized training. If you have NOT received this training in the last 2 years, you are NOT qualified to package or ship these materials and may be personally liable for any damages or fines. Contact one of Tetra Tech’s shipping experts for assistance. Instructions to access the training course, shipping experts, and health and safety (H&S) contacts, and general information on packaging and shipping hazardous substances and dangerous goods can be obtained by checking the links provided in [Section 1.4](#) (References) and communicating with appropriate Tetra Tech H&S contacts listed on the EMI Operating unit internal H&S web site.

1.2 SCOPE

This SOP applies to packaging and shipping of environmental and nonhazardous samples. This SOP does not address shipping dangerous goods or hazardous materials.

1.3 DEFINITIONS

Airbill: An airbill is a shipping form (such as a FedEx shipping form) acquired from the commercial shipper and is used to document shipment of the samples from the sampler to the designated analytical laboratory (see [Figure 1](#)).

Blank: A blank is any sample that is used to assess cross-contamination from sampling and sample management procedures. A typical blank sample will consist of distilled or deionized (DI) water (water sampling) or an air filter cartridge (air sampling) that is then analyzed by the laboratory to evaluate whether cross-contamination has been introduced. Each blank is assigned its own unique sample number. Blanks collected in the field include trip blanks, field blanks, and equipment blanks, all intended to assess potential cross-contamination. For example, a trip blank checks for contamination during sample handling, storage, and shipment from the field to the laboratory. Field blanks assess the contamination of water or soil from ambient air. Equipment blanks (also known as rinse blanks) assess contamination from incomplete decontamination procedures.

Chain-of-Custody form: A chain-of-custody form is used to document the transfer of custody of samples from the field to the designated analytical laboratory (see [Figure 2](#)). The chain-of-custody form is critical to the chain-of-custody process and is used to identify the samples in each shipping container to be shipped or delivered to the laboratory for chemical or physical (geotechnical) analysis. A copy of the chain-of-custody form is shipped with the samples and accompanies them from sampler to laboratory (see [Figure 3](#)).

Custody seal: A custody seal is a tape-like seal and is used to indicate that samples are intact and have not been disturbed during shipping or transport after the samples have been released from the sampler to the shipper (see [Figure 4](#)). The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been packaged for shipping (see [Figure 5](#)).

Environmental samples: Environmental samples include drinking water, groundwater, surface water, soil, sediment, treated municipal and industrial wastewater effluent, indoor and ambient air, nonhazardous bulk materials, soil gas, dust, asbestos, and biological specimens. Environmental samples typically contain low concentrations of contaminants and, when handled, require only limited precautionary procedures.

Nonhazardous samples: Nonhazardous samples are those samples that do not meet the definition of a hazardous sample AND do not need to be packaged and shipped in accordance with the International Air Travel Association's (IATA) "Dangerous Goods Regulations" (DGR) or U.S. Department of Transportation's "Hazardous Materials Regulations" defined in Title 49 *Code of Federal Regulations* (CFR).

The following definitions are provided to further distinguish environmental and nonhazardous samples from dangerous goods and hazardous samples:

Dangerous goods: Dangerous goods are articles or substances that can pose a significant risk to health, safety, or property when transported by air; they are classified as defined in Section 3 of the DGR (IATA 2020).

Hazardous samples: Hazardous samples include dangerous goods and hazardous substances. Hazardous samples shipped by air should be packaged and labeled in accordance with procedures specified by the DGR; ground shipments should be packaged and labeled in accordance with the Hazardous Material Regulations.

Hazardous substance: A hazardous substance is any material, including its mixtures and solutions, that is listed in 49 CFR 172.101 and its quantity, in one package, equals or exceeds the reportable quantity listed in Table 1 to Appendix A of 49 CFR 172.101.

1.4 REFERENCES

General Awareness, H&S Contacts, and Course Training Information (Tetra Tech, Inc., EMI Operating Unit. Intranet) On-line address: <https://int.tetrattech.com/sites/EMI/hs/Pages/Dangerous-Goods-Shipping.aspx>

International Air Transport Association (IATA). 2020. "Dangerous Goods Regulations. 2020." For sale at: <https://www.iata.org/en/publications/dgr/>. Updated annually, with new edition available late in year.

U.S. Environmental Protection Agency (EPA). 40 CFR, 763 Subpart F, Asbestos Hazards Emergency Response Act (AHERA).

EPA. 2014. "Contract Laboratory Program Guidance for Field Samplers." EPA 540-R-014-013. October. On-line address: https://www.epa.gov/sites/production/files/2015-03/documents/samplers_guide.pdf.

EPA. 2020. "Packing, Marking, Labeling and Shipping of Environmental and Waste Samples." EPA Region 4, LSASDPROC-209-R4. February 23. On-line address: <https://www.epa.gov/sites/production/files/2015-06/documents/Shipping-Environmental-and-Waste-Samples.pdf>

1.5 REQUIREMENTS AND RESOURCES

The procedures for packaging and shipping samples require the following:

- Coolers (insulated ice chest) or other shipping containers appropriate to sample type
- Ice
- Bubble wrap or similar cushioning material
- Chain-of-custody forms and seals
- Airbills

- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)
- Large plastic garbage bags for lining the cooler
- Temperature blank sample bottle filled with distilled water can be included in the cooler if appropriate to sample type
- Trip blank samples used to check for volatile contamination during sample handling in the field should accompany sample containers during shipment from laboratory to field (empty containers) and from field to laboratory (filled containers). It should remain in the cooler with sample containers during the sampling event. Trip blanks should be requested from the laboratory when containers are initially ordered.

2.0 PROCEDURES

The following procedures apply to packaging and shipping nonhazardous and environmental samples.

2.1 PACKAGING SAMPLES

After they have been appropriately containerized and labeled, environmental samples should be packaged as described in this section. This section covers procedures for packing samples for delivery by commercial carrier (air or ground) and hand delivery of environmental samples (by employee or courier), as well as shipping asbestos and air quality samples. Note that these instructions are general; samplers also should be aware of client-specific requirements concerning the placement of custody seals or other packaging provisions.

2.1.1 Packaging Samples for Delivery by Commercial Carrier (Air or Ground)

Samples shipped by commercial carriers should be packed for shipment using the following procedures and in compliance with all carrier requirements:

Preparing the sample:

1. Allow a small amount of headspace in all bottles, or as instructed by the laboratory (except volatile organic compound [VOC] containers with a septum seal) to compensate for any changes in pressure and temperature during transfer.
2. Be sure the lids on all bottles are tight (will not leak). Lids maybe taped or sealed with custody seals as added protection or as required. For any sample containers that are not marked with a tare weight by the laboratory, cover the completed sample label on the container with clear tape to protect the label.
3. Place sample containers in resealable plastic bags.

Preparing the cooler:

1. Secure and tape the drain plug of the cooler with fiber or duct tape.
2. Line the cooler with a large plastic garbage bag before samples, ice, and absorbent packing material are placed in the cooler.
3. Wrap the sample containers in bubble wrap or line the cooler (bottom and sides) with a cushioning material to prevent breakage of bottles or jars during shipment.
4. If required by the laboratory for the analytical method, add a sufficient quantity of ice to the cooler to cool samples to 4 °C (± 2 °C). Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. If required, include one temperature blank (a sample bottle filled with distilled water) per cooler.

5. For VOC samples only, include one trip blank for VOC analysis per shipment matrix in each cooler.
6. Fill all remaining space between the bottles or jars with bubble wrap.
7. As each container is placed in the cooler, verify the sample information on the chain-of-custody form. The samples listed on the chain-of-custody form must match exactly with the contents of the cooler.
8. Securely fasten the top of the large garbage bag with tape (preferably plastic electrical tape).
9. If more than one cooler is being shipped, mark each cooler as “1 of 2,” “2 of 2,” and so forth.
10. Place the chain-of-custody forms (see [Figure 2](#)) into a resealable plastic bag, and tape the bag to the inner side of the cooler lid (see [Figure 3](#)). If you are shipping more than one cooler, copy the chain-of-custody form so that there is one copy of all forms in each cooler. The samples listed on the chain-of-custody form must match exactly with the contents of the cooler. Tape any instructions for returning the cooler to the inside of the lid.
11. Close the lid of the cooler and tape it shut by wrapping strapping tape around both ends and hinges of the cooler at least once.
12. Place two signed custody seals (see [Figure 4](#)) on opposite sides of the cooler, ensuring that each one covers the cooler lid and side of the cooler (see [Figure 5](#); note that in contrast to the figure, the seals should be placed on the opposite sides of the cooler and offset from each other, rather than directly across from each other as shown in [Figure 5](#)). Place clear plastic tape over the custody seals so that the cooler cannot be opened without breaking the seal.
13. Shipping containers should be marked “THIS END UP.” Arrow labels, which indicate the proper upward position of the container, may also be affixed to the container. As appropriate, the containers should also be labeled for Saturday delivery or other special requirements.
14. Ship samples overnight using a commercial carrier such as FedEx. As a best practice, electronic sample shipping labels should be prepared by the shipping agency’s employees, at the direction of Tetra Tech employees or sampling personnel. This allows the sampling personnel to confirm special shipping requirements, such as Saturday delivery, and verify that samples will be shipped that day (that is, the last shipment of the day has not already occurred). If this is not possible, the airbill can be prepared by hand (see [Figure 1](#)), but samples should still be handed over directly to shipping agency employees and shipping details should be verified. The shipping label should be placed on the outside of the container.
15. A copy of the receipt with sample tracking number should be retained by the sampling personnel and delivery should be verified the next day.

2.1.2 Hand Delivery of Environmental Samples (by Employee or Courier)

Samples hand-delivered to the laboratory should be packed for shipment using the following procedures:

Preparing the sample:

1. Bottles can be filled completely with sample (required for VOC containers with a septum seal).

2. Be sure the lids on all bottles are tight (will not leak).

Preparing the cooler:

1. Secure and tape the drain plug of the cooler with fiber or duct tape.
2. Wrap the sample containers in bubble wrap or line the cooler (bottom and sides) with a cushioning material to prevent breakage of bottles or jars during shipment.
3. As each container is placed in the cooler, verify the sample information on the chain-of-custody form. The samples listed on the chain-of-custody form must match exactly with the contents of the cooler.
4. If required for by the laboratory for the analytical method, add a sufficient quantity of ice to the cooler to cool samples to 4 °C. Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. If required, include one temperature blank (a sample bottle filled with distilled water) per cooler.
5. For VOC samples only, include one trip blank for VOC analysis per shipment matrix in each cooler.
6. If more than one cooler is being shipped, mark each cooler as “1 of 2,” “2 of 2,” and so forth.
7. Place the chain-of-custody form (see [Figure 2](#)) in a resealable plastic bag and tape to the inside of the cooler lid (see [Figure 3](#)), close the lid, and seal with custody seals (see [Figure 5](#); note that in contrast to the figure, the seals should be placed on the opposite sides of the cooler and offset from each other, rather than directly across from each other as shown in [Figure 5](#)). Place clear plastic tape over the custody seals so that the cooler cannot be opened without breaking the seal. Transfer the cooler to the courier. When samples will be delivered directly to the laboratory, it is sufficient to close the cooler and hand-deliver it with the chain-of-custody form.
8. Include any instructions for returning the cooler to the inside of the lid.
9. If the cooler is being transferred to a courier, the shipping containers should be marked “THIS END UP,” and arrow labels, which indicate the proper upward position of the container should be affixed to the container.

2.1.3 Shipping Asbestos Samples

Asbestos samples shipped by commercial carriers should be packed for shipment using the following procedures and in compliance with all carrier requirements:

1. Place each asbestos sample in a small resealable plastic bag or Whirl-pak sealable bag. Seal the bags carefully and place the sample bags in a larger resealable plastic bag.
2. Select a rigid shipping container and pack the samples upright in a noncontaminating, nonfibrous medium such as a bubble pack to minimize excessive movement during shipping.
3. Avoid using expanded polystyrene because of its static charge potential. Also avoid using particle-based packaging materials because of possible contamination.

4. Affix custody seals to the samples or outer sample bag so that the bags cannot be opened without breaking the seal.
5. Insert the chain-of-custody form in the box. Include a shipping bill and a detailed listing of samples shipped, their descriptions and all identifying numbers or marks, sampling data, shipper's name, and contact information.
6. Ship bulk samples in a separate container from air samples. Bulk samples and air samples delivered to the analytical laboratory in the same container will be rejected.
7. For each sample set, designate which are the ambient samples, which are the abatement area samples, which are the field blanks, and which is the sealed blank if sequential analysis is to be performed.
8. Hand-carry samples to the laboratory in an upright position if possible; otherwise, choose that mode of transportation least likely to shake the samples in transit.
9. Address the package to the laboratory sample coordinator by name when known and alert him or her of the package description, shipment mode, and anticipated arrival as part of the chain-of-custody and sample tracking procedures. This information will also help the laboratory schedule timely analysis for the samples when they are received.

2.1.4 Shipping Air Samples

Packaging and shipping requirements for air samples vary depending on the media used to collect the samples and the analyses required. Sampling media typically include Summa canisters and Tedlar bags for whole air samples, filters for metals and particulate matter, and sorbent tubes for organic contaminants. This section of the SOP provides general guidelines for packaging and shipping air samples collected using these media. The project FSP or QAPP should also be reviewed for any additional project-specific requirements or instructions.

Summa Canister Samples

1. Close the canister valve by tightening the knob clockwise or flipping the toggle switch. Replace the brass cap on the canister inlet.
2. If a flow controller was used to collect the air sample over a specified time interval, the flow controller should be removed before replacing the brass cap.
3. Fill out the sample tag on the canister with the sample number and the date and time of collection. Include the identification number of the flow controller on the sample tag if one was used. Make sure the information on the sample tag matches the chain-of-custody form.
4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final Summa canister vacuum readings; Summa canister identification number; and flow controller identification number.

5. Package the Summa canister (and flow controller) in its original shipping box with the original packaging material. Tape the box shut and apply custody seals if required. Note: Summa canisters should never be packaged with ice.
6. Summa canister shipments typically include several canisters, and may include more than one shipping box. The chain-of-custody form for the shipment should be sealed within one of the shipping boxes. If more than one box is being shipped, mark each box as “1 of 2,” “2 of 2,” and so forth.
7. Ship the samples by a method that will meet the holding time. Summa canister samples should be analyzed within 30 days of sample collection.

Tedlar Bag Samples

1. Before removing it from the sample port, close the Tedlar bag by tightening the valve clockwise. The bag should only be approximately half-full to allow for pressure changes during shipping and handling of the sample. Keep the Tedlar bag out of direct sunlight to preserve the sample.
2. Fill out the label on the bag with the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. Complete the chain-of-custody form.
4. Package the Tedlar bag in a shipping box with appropriate packing material to prevent the bag from being punctured or damaged. Multiple bags can be packaged in the same box. Tape the box shut and apply custody seals if required. Note: Tedlar bag samples should not be cooled or packaged with ice, although they can be shipped in an ice chest to protect the samples.
5. Tedlar bag shipments may include more than one shipping box. The chain-of-custody form for the shipment should be sealed within one of the shipping boxes. If more than one box is being shipped, mark each box as “1 of 2,” “2 of 2,” and so forth.
6. Ship the samples using priority overnight delivery. Tedlar bag samples should be analyzed within 3 days of sample collection.

Filter Cassette Samples

1. Disconnect the filter cassette from the air sampling pump and replace the plastic caps on the inlet and outlet openings.
2. Attach a label to the sample that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.
4. Package the filter cassettes in a shipping box (such as a FedEx box). Use an appropriate packing material (such as bubble wrap) to separate the samples and prevent damage.
5. Place the chain-of-custody form within the box, seal the box, and apply custody seals if required. Filter cassette samples typically do not need to be cooled, but check the field sampling plan (FSP) or Quality Assurance Project Plan (QAPP) for project-specific requirements.

6. Ship the samples by a method that will meet the holding time.

Sorbent Tube Samples

1. Disconnect the sample tube from the air sampling pump and seal both ends of the tube with plastic caps.
2. Complete a sample label that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. If the tube is small and the label cannot be attached to the tube, the tube can be placed in a small resealable plastic bag and the label can be attached to the bag or placed inside the bag with the tube.
4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.
5. Packaging requirements for the sample tubes will depend on the analysis required, and the sampler should check the FSP or QAPP for project-specific requirements (for example, tubes may need to be wrapped in aluminum foil to prevent exposure to light). Packaging containers and methods include (1) shipping boxes (as described under filter cassette samples), (2) small sample coolers filled with double-bagged ice, and (3) small sample coolers filled with blue (reusable) ice.
6. Place the chain-of-custody form within the box or container, seal the box or container, and apply a custody seal if required.
7. If coolers are used for shipping, tape instructions for returning the cooler to the inside of the lid.
8. Ship the samples by a method that will meet the holding time.

Polyurethane Foam (PUF) Tube Samples

1. Disconnect the PUF tube from the air sampling pump and wrap the tube in aluminum foil.
2. Attach a label to the wrapped sample tube that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. Wrap the PUF tube in bubble wrap and place the tube in a glass shipping jar.
4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.
5. Package the PUF tube jars in a cooler that is filled with double-bagged ice. Use bubble wrap or other cushioning material to separate the samples and prevent breakage.
6. Place the chain-of-custody form within the cooler, seal the cooler, and apply a custody seal if required.
7. If coolers are used for shipping, tape instructions for returning the cooler to the inside of the lid.
8. Ship the samples by a method that will meet the holding time. Samples collected in PUF tubes typically must be extracted within 7 days of collection.

2.2 SHIPPING DOCUMENTATION FOR SAMPLES

Airbills, chain-of-custody forms, and custody seals must be completed for each shipment of nonhazardous environmental samples.

Field staff collecting samples should also review their field work plans to confirm what documentation must be completed during each sampling event, including client-specific requirements. For example, some EPA programs have a specific requirement to use Scribe software, an environmental data management system, to create sample documentation, electronically input information into Traffic Report or chain-of-custody forms, and enter other data.

- The Scribe software can be accessed from the EPA Environmental Response Team (ERT) at the following address: http://www.ertsupport.org/scribe_home.htm
- The ERT User Manual for Scribe, reference, and training materials can be accessed from the Scribe Support Web site at the following address: <http://www.epaossc.org/scribe>

Note that some laboratories must routinely return sample shipping coolers within 14 calendar days after the shipment has been received. Therefore, the sampler should also include instructions for returning the cooler with each shipment, when possible. The sampler (not the laboratory) is responsible for paying for return of the cooler and should include shipping airbills bearing the sampler's shipping account number, as well as a return address to allow for return of the cooler. Samplers should use the least expensive option possible for returning coolers.

2.3 SHIPMENT DELIVERY AND NOTIFICATION

A member of the field sampling team must contact the laboratory to confirm it accepts deliveries on any given day, especially Saturdays. In addition, samplers should ensure the laboratory has been notified in advance of the pending shipment and notify any additional parties as required. The sampler needs to know the laboratory's contact name, address, and telephone number and be aware of the laboratory's requirements for receiving samples.

In addition, samplers should be aware of the sample holding times, shipping company's hours of operation, shipping schedule, and pick-up and drop-off requirements to avoid delays in analytical testing.

Priority Overnight Delivery

Priority overnight delivery is typically the best method for shipment. Delays caused by longer shipment times may cause the sample temperature to rise above the acceptable range of 4° C ($\pm 2^{\circ}$ C) and technical holding time may expire, which in turn may compromise sample integrity and require recollection of

samples. If sample delivery procedures are to be modified for particular contract- or laboratory-specific requirements, the procedures should be clearly described in site-specific plans such as work plans, FSPs, or QAPPs.

Saturday Delivery

If planning to ship samples for Saturday delivery, the laboratory must be contacted in advance to confirm it will accept deliveries on Saturdays or arrange for them to be accepted. In addition, samplers should ensure the laboratory has been notified in advance of the pending shipment and notify any additional parties as required.

2.4 HEALTH AND SAFETY CONSIDERATIONS

In addition to the procedures outlined in this SOP, all field staff must be aware of and follow the health and safety practices that result from the Activity Hazard Analyses (AHA) for the project. The AHAs include critical safety procedures, required controls, and minimum personal protective equipment necessary to address potential hazards. The hazards specific to project tasks must be identified and controlled to the extent practicable and communicated to all project personnel via the approved, project-specific health and safety plan (HASP).

3.0 POTENTIAL PROBLEMS

The following potential problems may occur during sample shipment:

- Leaking package. If a package leaks (either from broken sample containers or melting ice), the carrier may open the package and return the package. Special care should be taken during sample packaging to minimize potential leaks.
- Improper labeling and marking of package. If mistakes are made in labeling and marking the package, the carrier will most likely notice the mistakes and return the package to the shipper, thus delaying sample shipment. A good practice is to have labels, forms, and container markings double checked by a member of the field team.
- Bulk samples and air samples delivered to the analytical laboratory in the same container. If samples are combined in this way, they will be rejected. Always ship bulk samples in separate containers from air samples.
- Issues in packing asbestos samples. When asbestos samples are shipped, avoid using expanded polystyrene because of its static charge potential. Also avoid using particle-based packaging materials with asbestos samples because of possible contamination.
- Improper, misspelled, or missing information on the shipper's declaration. The carrier will most likely notice these errors as well and return the package to the shipper. A good practice is to have another field team member double check this information.
- Missed drop off time or wrong location. Missing the drop off time or having the wrong location identified for drop off will delay delivery to the laboratory and may cause technical holding times to expire. Establish the time requirements in advance of completing the field effort and be sure and provide some contingency time for potential delays such as traffic or checking and redoing paperwork.
- Incorrectly packaging samples for analysis at multiple laboratories. For example, inorganic samples may be shipped to one laboratory for analysis, while organic samples may need to be shipped to another laboratory. All field staff should be aware which samples are to be shipped to which laboratory when they package samples for multiple types of analysis.
- Holidays or weather-related delays. Be aware of holidays and weather forecasts that could cause delays in delivery. Delays caused by longer shipping times may cause technical holding times to expire, which in turn may compromise sample integrity or require recollection of samples.
- Not noting field variances in field logbook. Field variances should be noted in the field logbook and the project manager notified. Common field variances include:
 - Less sample volume collected than planned. Notify appropriate staff and the laboratory to ensure there is an adequate amount for analysis.
 - Sample collected into incorrect jar because of broken or missing bottle-ware. Notify appropriate laboratory staff to ensure there is no confusion regarding the analysis of the sample.

FIGURE 1

EXAMPLE OF A FEDEX US AIRBILL FOR LOW-LEVEL ENVIRONMENTAL SAMPLES

FedEx Package US Airbill

1 **From** Please print and print hard. Sender's FedEx Account Number: 1234 5678 9010
Date: 3/1/20 Sender's Name: Tyler Hanlon Phone: 662 | 555-1812
Company:
Address: 1234 Main Street
City: Phoenix State: AZ ZIP: 85034

2 **Your Internal Billing Reference**
First 10 characters will appear on invoice.

3 **To** Recipient's Name: Liam Riley Phone: 405 | 555-8300
Company: Ridgeway Design
Address: 2020 Vision Street
City: Atlanta State: GA ZIP: 30305

4 **Express Package Service** *To most locations. Packages up to 150 lbs. An additional \$50 fee will be charged for FedEx Express Freight/Global.
Next Business Day
☐ FedEx First Overnight
☒ FedEx Priority Overnight
☐ FedEx Standard Overnight
2 or 3 Business Days
☐ FedEx 2Day AM
☐ FedEx 2Day
☐ FedEx Express Saver

5 **Packaging** *Declared value limit \$500.
☐ FedEx Envelope* ☐ FedEx Pak* ☐ FedEx Box ☐ FedEx Tube ☒ Other

6 **Special Handling and Delivery Signature Options** *See copy copy for the FedEx Service Guide.
☐ Saturday Delivery
☐ No Signature Required
☒ Direct Signature
☐ Indirect Signature
Does this shipment contain dangerous goods?
☒ No ☐ Yes ☐ Yes (Dangerous Goods) ☐ Yes (Hazardous Materials) ☐ Yes (Other)

7 **Payment** Bill to:
☒ Sender ☐ Recipient ☐ Third Party
Total Packages: 1 Total Weight: 1 Total Declared Value: 450

Filling Out the FedEx US Airbill

- The sender *must complete* the following fields on the pre-printed airbill:
 - Section 1: Date
 - Section 1: Sender's FedEx Account Number (available from your office administrator)
 - Section 1: Sender's Name, Company, Address, and Phone Number
 - Section 2: Internal Billing Reference (Project Number) (this field may not be present on newer airbills)
 - Section 3: Recipient's Name, Company, Address, and Phone Number
 - Section 4: Express Package or Freight Services (Priority Overnight)
 - Section 5: Packaging (usually "Other," your own packaging)
 - Section 6: Special Handling (Saturday delivery if prearranged with receiving laboratory; "No" dangerous goods contained in shipment)
 - Section 7: Payment ("Bill to Sender")
 - Section 7: Total Number of Packages
 - Section 7: Total Weight (completed by FedEx employee)
 - Section 8: Delivery Signature Options ("No Signature Required")

Completing a Sample Chain-of-Custody Form (See Also Section 2.2 on SCRIBE for Forms)

After samples have been collected, they will be maintained under chain-of-custody procedures. These procedures are used to document the transfer of custody of the samples from the field to the designated

analytical laboratory. The same chain-of-custody procedures will be used for the transfer of samples from one laboratory to another, if required.

The field sampling personnel will complete a Chain-of-Custody and Request for Analysis (CC/RA) form for each separate container of samples to be shipped or delivered to the laboratory for chemical or physical (geotechnical) analysis. These forms are often triplicate, carbonless forms. Care should be taken when completing the form that all copies are legible—PRESS FIRMLY WHEN WRITING. Information on the form will include:

1. Project identification (ID) (for example, contract and task order number);
2. Project Contract Task Order (CTO) number;
3. Laboratory Project Order (PO) number;
4. Tetra Tech Technical Contact;
5. Tetra Tech Project Manager;
6. Laboratory name;
7. Field sampler names;
8. Field sampler signature;
9. Sample ID;
10. Date and time of sampling;
11. Sample matrix type;
12. Sample preservation method; note “NONE” if no preservatives;
13. Number and types of containers per sample;
14. Sample hazards (if any);
15. Requested analysis;
16. Requested sample turnaround time or any special remarks (for example, possible presence of free product or high screening concentrations);
17. Page __ of __;
18. Method of shipment;
19. Carrier/waybill number (if any);
20. Signature, name, and company of the person relinquishing the samples and the person receiving the samples when custody is transferred;

21. Date and time of sample custody transfer;
22. Condition of samples when they are received by the laboratory.


The sample collector will cross out any blank space on the CC/RA form below the last sample number listed on the part of the form where samples are listed.

The sampling personnel whose signature appears on the CC/RA form is responsible for the custody of a sample from time the sample is collected until the custody of the sample is transferred to a designated laboratory, a courier, or to another Tetra Tech employee for transporting a sample to the designated laboratory. A sample is considered to be in custody when the custodian: (1) has direct possession of it; (2) has plain view of it; or (3) has securely locked it in a restricted access area.

Custody is transferred when both parties to the transfer complete the portion of the CC/RA form under “Relinquished by” and “Received by” or a sample is left at a FedEx facility pending shipment. Signatures, printed names, company names, and date and time of custody transfer are required. When custody is transferred, the Tetra Tech sampling personnel who relinquished the samples will retain the third sheet (pink copy) of the CC/RA form. When the samples are shipped by a common carrier, a Bill of Lading supplied by the carrier will be used to document the sample custody, and its identification number will be entered on the CC/RA form. Receipts of Bills of Lading will be retained as part of the permanent documentation in the Tetra Tech project file.

FIGURE 2

EXAMPLE OF A CHAIN-OF-CUSTODY FORM (WHITE COPY)



Tetra Tech EM Inc.
 Oakland Office
 1999 Harrison Street, Suite 500
 Oakland, CA 94612
 510.302.6300 Phone
 510.433.0830 Fax

Chain of Custody Record No. 9814 13G175 Page 1 of 1

Lab PO#: <u>130AK 27</u>		Lab: <u>EMAX</u>		No./Container Types		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="8">Preservative Added</th> </tr> <tr> <td><u>NONE</u></td> <td><u>NONE</u></td> <td><u>NONE</u></td> <td><u>NONE</u></td> <td><u>NONE</u></td> <td><u>NONE</u></td> <td><u>NONE</u></td> <td><u>NONE</u></td> </tr> </table>								Preservative Added								<u>NONE</u>	<u>NONE</u>	<u>NONE</u>	<u>NONE</u>	<u>NONE</u>	<u>NONE</u>	<u>NONE</u>	<u>NONE</u>
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Project name: <u>Concord RA RW1</u>		TEMI technical contact: <u>Sara Woolley</u>		Field samplers: <u>Sandy Jack</u> <u>Rebecca Johnson</u>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="8">Analysis Required</th> </tr> <tr> <td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td> </tr> </table>								Analysis Required								<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Project (CTO) number: <u>1036H59029</u>		TEMI project manager: <u>Steve DelHomme</u>		Field samplers' signatures: <u>[Signature]</u> <u>[Signature]</u>																									
Sample ID	Point ID/Depth	Date	Time	Matrix	MS / MSD	40 ml VOA	1 liter Amber	500 ml Poly	Sieve	Glass Jar	250 ml Poly	Encore	VOA	SVOA	Pest	Metals	TPH Purgeables	TPH Extractables	PCB										
1 0295RE SSØ1		7/22/13	1240	Soil																									
2 0295RE SSØ2		7/22/13	1245																										
3 0295C3 DSSØ1		7/24/13	1208																										
4 029C3D SSØ2			1215																										
5 029C3D SSØ3			1230																										
6 029C3D SSØ4			1245																										

Relinquished by:	Name (print)	Company Name	Date	Time
<u>[Signature]</u>	<u>Rebecca Johnson</u>	<u>Tetra Tech</u>	<u>7/20/13</u>	<u>1630</u>
<u>[Signature]</u>	<u>Rebecca Johnson</u>	<u>EMAX</u>	<u>7/30/13</u>	<u>0930</u>
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

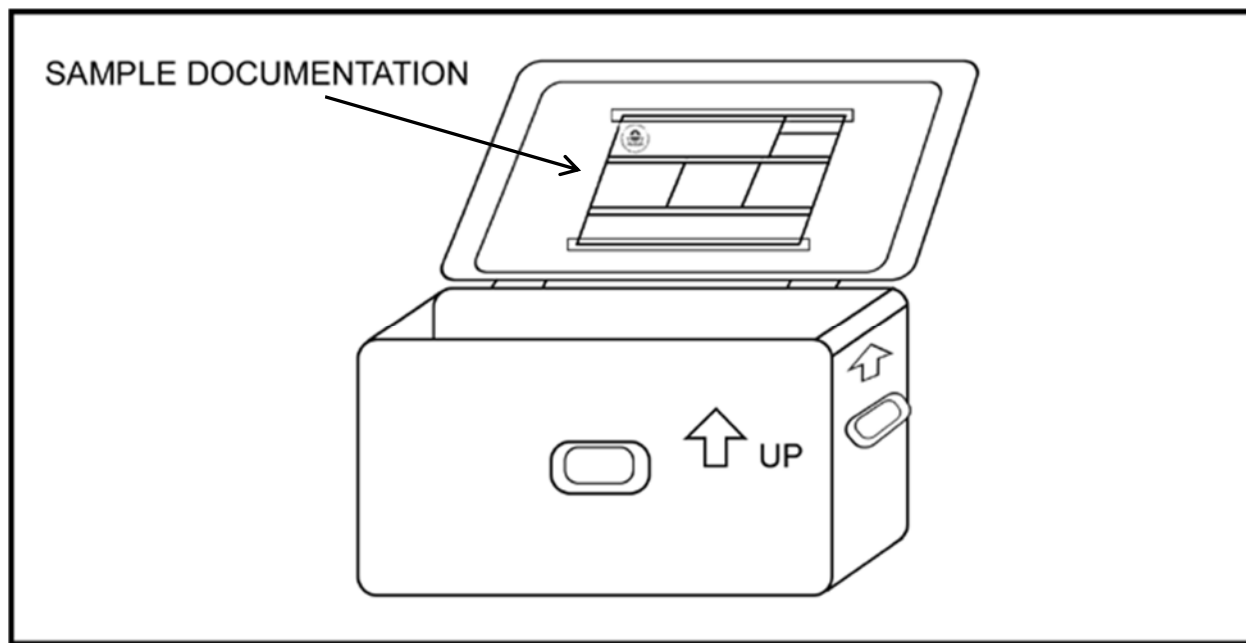
Turnaround time/remarks: Standard TAT Temp - 20°C

Priority: SVOCs, TPH-e on 029C3DSSØ1 → Ø4 then metals

Fed Ex #: 8612 4667 7215

FIGURE 3

EXAMPLE OF A SAMPLE COOLER WITH ATTACHED DOCUMENTATION



Source: U.S. Environmental Protection Agency. 2014.

Place the necessary paperwork (chain-of-custody form, cooler return instructions, and associated paperwork) in the shipping cooler or acceptable container. All paperwork must be placed in a plastic bag or pouch and then secured to the underside of the shipping container lid.

FIGURE 4

EXAMPLE OF A CUSTODY SEAL

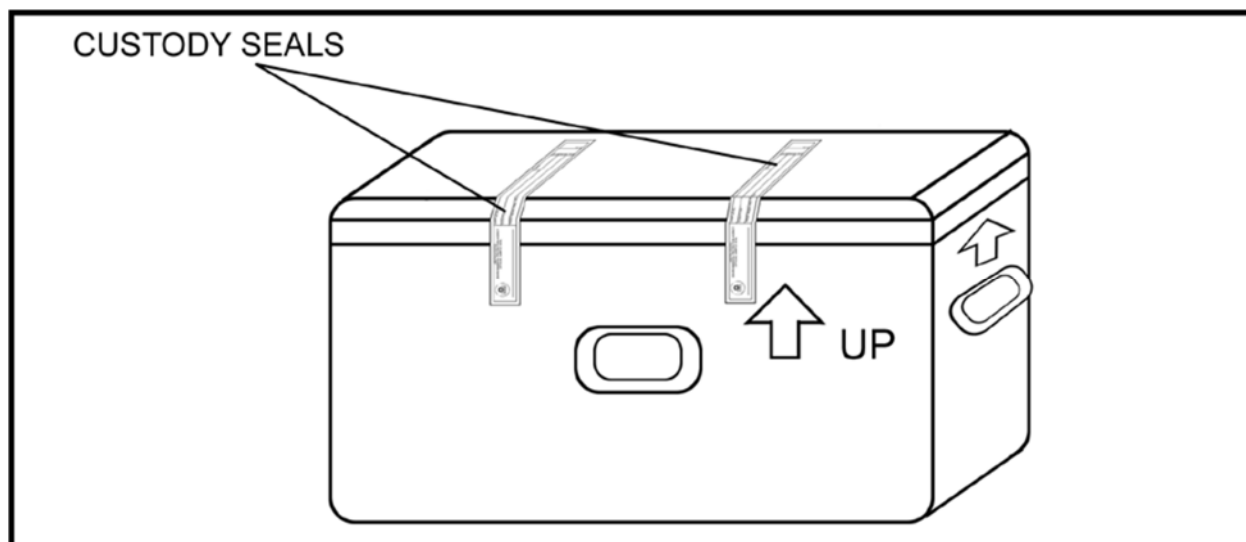
Custody Seal

DATE

SIGNATURE

FIGURE 5

EXAMPLE OF SHIPPING COOLER WITH CUSTODY SEALS



Source: U.S. Environmental Protection Agency. 2014.

Please note that the two seals typically are affixed to opposite sides of the cooler and offset from each other, although the offset is not depicted on the EPA figure above.

SOP APPROVAL FORM

TETRA TECH, INC.

EMI OPERATING UNIT

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

RECORDING NOTES IN FIELD LOGBOOKS

SOP NO. 024

REVISION NO. 3

Last Reviewed: July 2020



Quality Assurance Approved

July 2, 2020

Date

1.0 BACKGROUND

Complete and accurate field documentation is critical to a successful project and the field logbook is an important tool to support field documentation needs. The field logbook should include detailed records of all field activities, document interviews with people, and record observations of conditions at a site. Entries should be described in a level of detail to allow personnel to reconstruct, after the fact, activities and events that occurred during their field assignments. Furthermore, entries should be limited to facts. Avoid speculation related to field events and do not record hearsay or unfounded information that may be presented by other parties during field activities. For example, do not record theories regarding the presence or absence of contamination when you are collecting field screening data or speculation regarding the reasons for a property owner's refusal to grant access for sampling.

Field logbooks are considered accountable documents in enforcement proceedings and may be subject to review. Therefore, the entries in the logbook must be accurate and detailed, but should not contain speculative information that could conflict with information presented in subsequent project deliverables and correspondence. Also be aware that the field logbooks for a site may be a primary source of information for depositions and other legal proceedings that may occur months or years after field work is complete and long after our memories have faded. The accuracy, neatness, and completeness of field logbooks are essential for recreating a meaningful account of events.

Field notes may also be recorded digitally, using a variety of software programs. The requirements and use of digital recording programs is not addressed in this standard operating procedure (SOP) because many items are unique to the selected software system. However, many of the principles discussed in this SOP will apply to the digital recording of field notes.

1.1 PURPOSE

The purpose of this SOP is to provide guidance to ensure that field logbook documentation collected during field activities meets all requirements for its later use. Among other things, field logbooks may be used for:

- Identifying, locating, labeling, and tracking samples
- Recording site activities and the whereabouts of field personnel throughout the day
- Documenting any deviations from the project approach, work plans, quality assurance project plans, health and safety plans, sampling plans, and any changes in project personnel
- Recording arrival and departure times for field personnel each morning and evening and weather conditions each day

- Describing photographs taken during the project.

In addition, the data recorded in the field logbook may later assist in the interpretation of analytical results. A complete and accurate logbook also aids in maintaining quality control, because it can verify adherence to project scope and requirements.

1.2 SCOPE

This SOP establishes the general requirements and procedures for documenting site activities in the field logbook.

1.3 DEFINITIONS

None.

1.4 REFERENCES

Compton, R.R. 1985. *Geology in the Field*. John Wiley and Sons. New York, NY.

1.5 REQUIREMENTS AND RESOURCES

The following items are required for field notation:

- Bound (sewn) notebooks
- Ballpoint pens or Sharpies with permanent waterproof ink
- 6-inch ruler (optional)

Field logbooks should be bound (sewn) with water-resistant and acid-proof covers, and each page should have preprinted lines or grids and numbered pages. They should be approximately 7¹/₂ by 4¹/₂ inches or 8¹/₂ by 11 inches in size. Loose-leaf sheets are not acceptable for use as a field logbook, although logs and field forms used to record field measurements and data are acceptable as loose-leaf sheets maintained in a three-ring binder with numbered pages, as a supplement to the logbook. If notes are written on loose paper, they must be transcribed as soon as possible into a bound field logbook by the same person who recorded the notes originally.

Ideally, distribution of logbooks should be controlled by a designated person in each office. This person assigns a document control number to each logbook, and records the assignment of each logbook distributed (name of person, date distributed, and project number). The purpose of this procedure is to ensure the integrity of the logbook before its use in the field, and to document each logbook assigned to a

project. In the event that more than one logbook is assigned to a project, this process will ensure that all logbooks are accounted for at project closeout.

2.0 PROCEDURES

The following subsections provide general guidelines and formatting requirements for field logbooks, and detailed procedures for completing field logbooks.

2.1 GENERAL GUIDELINES

- A separate field logbook must be maintained for each project. If a site consists of multiple subsites (or operable units), designate a separate field logbook for each subsite. Similarly, if multiple activities are occurring simultaneously requiring more than one task leader (for example, well installation, private well sampling, or geophysical survey), each task leader should maintain a separate field logbook to ensure that each activity is documented in sufficient detail.
- At larger sites, a general field log may be kept at the site trailer or designated field office to track site visitors, document daily safety meetings, and record overall site issues or occurrences.
- Data from multiple subsites may be entered into one logbook that contains only one type of information for special tasks, such as periodic well water-level measurements.
- All logbooks must be bound and contain consecutively numbered pages. If the pages are not pre-numbered, the sequential page number should be written at the top of each page.
- No pages can be removed from the logbook for any purpose.
- All information must be entered using permanent, waterproof ink, either a traditional ballpoint pen or a permanent marker. Do not use pens with water-based ink (typically identified as rollerball or gel ink pens) because the ink may wash out if the paper gets wet. Pencils are not permissible for field notes because information can be erased. The entries should be written dark enough so that the logbook can be easily photocopied.
- Be sure that all entries are legible. Use print rather than cursive writing and keep the logbook pages free of dirt and moisture to the extent possible.
- Set apart critical information such as sample numbers by circling or drawing a box around the critical data.
- Do not enter information in the logbook that is not related to the project. The language used in the logbook should be factual and objective. Avoid speculation that could conflict with information presented in subsequent project deliverables and correspondence (see Section 1.0 above).
- Use military time, unless otherwise specified by the client. If a logbook entry is not related to a specific event, set it aside with the identification as a “NOTE.”
- Include site sketches, as appropriate.
- Begin a new page for each day’s notes.
- Include the date, project number, and location (if the project has multiple locations) at the top of each page.

- At the end of a day, draw a single diagonal line through any unused lines on the page, and sign at the bottom of the page. Note and implement any client-specific requirements (for example, some clients require each logbook page to be signed).
- Write notes on every line of the logbook. Do not skip any pages or parts of pages unless a day's activity ends in the middle of a page.
- If a line is left blank for some reason, cross it out (with a single line) and initial to prevent unauthorized entries.
- Cross out (with a single line) and initial any edits to the logbook entries. Note and implement any client-specific requirements (for example, some clients also require that edits be dated). Edits should only be made if the initial entry is illegible or erroneous. Do not make corrections for grammar or style.

2.2 LOGBOOK FORMAT

The layout and organization of each field logbook should be consistent and generally follow the format guidelines presented below. Some clients or contracts may have specific formatting guidelines that differ somewhat from this SOP; review client requirements at the start of the project to help ensure any client-specific guidelines are integrated.

2.2.1 Logbook Cover

Spaces are usually provided on the inside front cover (or the opening page in some logbooks) for the company name, address, contact names, and telephone numbers. If preprinted spaces for this information are not provided in the logbook, write the information on the first available page. Information to be included on the inside front cover or first page includes:

- Logbook document control number (assigned by issuer)
- "Book # of #" (determined by the project manager if there is more than one logbook for the project)
- Contract and task order numbers
- Name of the site and site location (city and state)
- Name of subsite (or operable unit), if applicable
- Type of activity, if the logbook is for a specific activity, such as well installation or indoor air sampling
- Beginning and ending dates of activities entered into the logbook

2.2.2 Inside Cover or First Page

Spaces are usually provided on the inside front cover (or the opening page in some logbooks) for the company name, address, contact names, and telephone numbers. If preprinted spaces for this information are not provided in the logbook, write the information on the first available page. Information to be included on the inside front cover or first page includes:

- Tetra Tech project manager and site manager names and telephone numbers
- Tetra Tech office address
- Client contact and telephone number
- Site safety officer and telephone number
- Emergency contact telephone number (911, if applicable, or nearest hospital)
- Subcontractor contacts and telephone numbers
- Site property owner or property manager contact information

Note—some clients prohibit the inclusion of personally identifiable information such as personal mobile telephone numbers on official project records.

2.3 ENTERING INFORMATION IN THE LOGBOOK

The following lists provide guidance on the types of information to be included in a typical field logbook. This guidance is general and is not intended to be all-inclusive. Certain projects or clients may specify logbook requirements that are beyond the elements presented in this SOP.

2.3.1 General Daily Entries

- Document what time field personnel depart the Tetra Tech office and arrive at the hotel or site. If permitted by the client to charge travel time for site work, document what time personnel leave and arrive at the hotel each day. (This information may be needed at remote sites where hotel accommodations are not near the site.)
- Indicate when all subcontractors arrive and depart the site.
- Note weather conditions at the time of arrival on site and any changes to the weather that might affect completion of project tasks during the day.
- Include the date and project number at the top of each page.
- Document that a site safety meeting was held and include the basic contents of the meeting.
- List the level of personal protection to be used for health and safety.

- Summarize the day's planned activities.
- Summarize which activities each field team member will be doing.

2.3.2 Field Activity Entries

- Refer to field data collection forms for details about field data collection activities (for example time, date, depth of samples, and field measurements). If separate field sampling sheets are not used, see Section 2.3.3 regarding logbook entries for sampling activities.
- Refer to well purge forms, well construction logs, and other activity-specific forms as applicable rather than including this type of information in the field logbook. These other forms allow the information to be more accessible at a later date.
- List any air monitoring instrumentation used, with readings and locations.
- Refer to instrument field logs for equipment calibration information.
- Summarize pertinent conversations with site visitors (agency representatives, property owners, client contacts, and local citizens).
- Summarize any problems or deviations from the quality assurance project plan (QAPP) or field sampling plan.
- Document the activities and whereabouts of each team member. (As indicated in Section 2.1, multiple logbooks may be required to ensure sufficient detail for contemporaneous activities).
- Indicate when utility clearances are completed, including which companies participated.
- Indicate when verbal access to a property is obtained.
- Include names, addresses, and telephone numbers of any pertinent site contacts, property owners, and any other relevant personnel.
- Document when lunch breaks or other work stoppages occur.
- Include approximate scale for all diagrams. If a scale is not available, write "not to scale" on the diagram. Indicate the north direction on all maps and cross-sections, and label features on each diagram.

2.3.3 Sampling Activity Entries

The following information should typically be on a sample collection log and referenced in the logbook. If the project does not use sample sheets as a result of project-specific requirements, this information should be included in the logbook.

- Location description
- Names of samplers
- Collection time

- Designation of sample as a grab or composite sample
- Identification of blind duplicates or split samples
- Type of sample (water, sediment, soil gas, or other medium)
- On-site measurement data (such as pH, temperature, and specific conductivity)
- Field observations (odors, colors, weather)
- Preliminary sample description
- Type of preservative used
- Instrument readings, if applicable

2.3.4 Closing Daily Entries

- Describe decontamination procedures (personnel and equipment).
- Describe handling and disposition of any investigation-derived wastes.
- Summarize which planned activities were completed and which ones were not.
- Note the times that personnel depart the site for the day.
- Summarize any activities conducted after departing the site (paperwork, sample packaging, etc.). This may be required to document billable time incurred after field activities were completed for the day.

2.3.5 Photographic Log Entries

- Before using a digital camera, ensure that the system date and time are correct. Verify whether the timestamp is being recorded on the image, if required.
- Indicate in the text that photographs were taken and the location where the photographs can be found (for example, in the project file) and identify the photographer.
- Begin a new photolog page for each new field day.
- Record the time of photograph so that the image can be generally identified when reviewing the digital files.
- Note the direction in which the photograph was taken, along with any relevant details that might not be understood when looking at the photograph.
- In the event that a film camera is used, the sequential number of the image should also be recorded, and the time from the logbook will be the recorded time for the photograph.

2.4 LOGBOOK STORAGE

Custody of logbooks must be maintained at all times. During field activities, field personnel must keep the logbooks in a secure place (locked car, trailer, or field office) when the logbook is not in personal possession. When the field work is over, the logbook should be included in the project file, which should be in a secured file cabinet; in addition, if directed by the project manager, scan logbook pages for electronic file management upon returning to the office. The logbook may be referenced in preparing subsequent reports and scanned logbook pages may be included as an appendix to a report. However, it is advisable to obtain direction directly from the client before including the logbook as a report appendix, because its inclusion may not be appropriate in all cases.

2.5 HEALTH AND SAFETY CONSIDERATIONS

In addition to the procedures outlined in this SOP, all field staff must be aware of and follow the health and safety practices that result from the Activity Hazard Analyses (AHA) for a project. The AHAs include critical safety procedures, required controls, and minimum personal protective equipment necessary to address potential hazards. The hazards specific to project tasks must be identified and controlled to the extent practicable and communicated to all project personnel via the approved, project-specific health and safety plan.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

AIR QUALITY MONITORING

SOP NO. 073

REVISION NO. 2

Last Reviewed: August 2020



Quality Assurance Approved

August 5, 2020

Date

1.0 BACKGROUND

Air quality monitoring is performed to evaluate concentrations of airborne chemicals or other materials. Particulate matter, volatile organic compounds (VOC), semivolatile organic compounds (SVOC), and other gases and vapors in the air can present potential health risks to workers and other receptors. Reliable measurements of airborne contaminants are necessary for selecting or upgrading personal protective equipment (PPE), delineating areas where protection is needed, assessing the potential health effects of exposure, evaluating site conditions, and evaluating the need for specific medical monitoring. Air monitoring is frequently used in emergency responses, where immediate information is needed about a release or threatened release of hazardous substances that present an imminent danger to public health, welfare, or the environment. Air monitoring is also commonly used as a screening tool to identify relatively impacted environmental media and to provide a real-time basis for selecting samples for laboratory analysis.

Various types of air monitoring instruments are available to monitor each type of airborne contaminant. Common air monitoring instruments used by Tetra Tech include photoionization detectors (PIDs), flame ionization detectors (FIDs), oxygen meters, combustible gas indicators, multigas meters that combine organic and toxic sensors for inorganics, single point monitors, colorimetric instruments, compound-specific instruments, and particulate matter monitors. It should be noted that this standard operating procedure (SOP) discusses only some of the air monitoring instruments available to field personnel. The particular type of meter or monitoring system to be used should be identified in the project work plan, field sampling plan, or health and safety plan, and should be selected on a site-specific basis depending on the data collection needs, the airborne contaminants to be monitored, and the sampling procedures to be used.

1.1 PURPOSE

This SOP establishes the requirements and procedures for using various instruments to conduct air monitoring in the field. It also discusses general factors to consider when conducting air monitoring.

1.2 SCOPE

This SOP provides only a broad overview of recommendations for monitoring air quality and applies to general procedures for calibrating and operating air monitoring equipment in the field. The project work plan or field sampling plan should identify types of instruments to be used and the actual project-specific field parameters to be measured. The project-specific healthy and safety plan should identify chemical-

specific action levels for health and safety purposes. For each type of air monitoring instrument, the manufacturer's manual should be consulted for specific operating instructions.

This SOP is to be used in conjunction with Tetra Tech EMI SOP No. 003, "Organic Vapor Air Monitoring," U.S. Environmental Protection Agency (EPA) Environmental Response Team (ERT) SOPs, and instrument manuals and quick start guides developed by manufacturers or by qualified users of the monitoring equipment.

1.3 DEFINITIONS

Breathing Zone: The area where field workers would be inhaling potentially impacted air, generally from about 3 to 5 feet above ground surface. The breathing zone will vary depending on the types of work activities being performed. Air monitoring is conducted in this zone to ensure that it is representative of the air being breathed by field team members.

Direct Reading Instrument: Instrumentation operating on various detection principles such as photoionization, photometry, or spectroscopy to provide real time readings of ambient contaminants in air.

1.4 REFERENCES

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1.5 REQUIREMENTS AND RESOURCES

Depending on the type of air quality monitoring to be conducted, some or all of the following equipment will be required:

- Particulate monitoring meter, such as the TSI, Inc. DustTrak II Aerosol Monitor Model 8530 or DustTrak DRX Model 8533/8534 or similar
- Organic Vapor Air Monitoring Meter, such as the RAE Systems AreaRAE Pro, MultiRAE Pro, or UltraRAE 3000
- Compound-specific or compound-class-specific air monitoring meters, such as the Honeywell Single Point Monitor or SPM Flex, Lumex RA-915M mercury vapor analyzer, Jerome mercury vapor analyzers, or RAE Systems MultiRAE Benzene

- Manufacturer-supplied calibration kits, including tubing, regulators, and zeroing equipment
- Manufacturer-supplied calibration gas
- Telemetry hardware, such as Rae Systems RAELink 3 modems, Safe Environment Engineering VIPER Lincs and Gateways, or Field Data Solutions radio modems
- Logbook or field data sheets (may be in electronic form)
- Laptop equipped with telemetry software and wireless internet

2.0 APPLICATIONS, DETECTION METHODS, AND LIMITATIONS

All direct-reading instruments have inherent constraints in their ability to detect gaseous organic or inorganic compounds and particulates. They usually detect or measure only specific classes of chemicals or particulates. Generally, many direct-reading instruments that have been designed to detect one particular substance also respond to other substances, causing interferences and possibly resulting in false readings. Applications, detection methods, and limitations of organic air monitoring instruments can be found in Tetra Tech SOP No. 003. The following subsections discuss general applications, detection methods, and limitations when using air monitoring equipment.

2.1 APPLICATIONS

Air monitoring is used to help establish criteria for worker safety, document potential exposures, evaluate site conditions, and determine protective measures for site personnel and surrounding public. Air monitoring instruments can be used alone or as a network integrated using wireless telemetry to monitor for multiple contaminants at numerous locations.

Multigas meters such as the RAE Systems MultiRAE Pro and AreaRAE Pro have slots for electrochemical, carbon dioxide, oxygen, or combustible sensors in addition to the PID. Electrochemical sensors are available for a wide range of toxic gases. A list of available MultiRae Pro and AreaRae Pro sensors is available on the manufacturer's website and in the instrument user guides. When operated in datalog mode, the instrument records sensor readings to internal memory for download after the monitoring event. Refer to EPA ERT SOP No. ERT-PROC-2139-20, "Operation of the MultiRae Pro Wireless Portable Detector" and EPA ERT SOP No. ERT-PROC-2066-20, "Operation of the AreaRae Wireless Multi-Gas Monitor" for comprehensive standard operating procedures for the MultiRae Pro and AreaRae Pro (EPA, 2020a; EPA, 2020b).

TSI DustTrak DRX monitors or similar particulate monitors can be used to obtain real-time readings of size-segregated mass fractions of particulates with aerodynamic diameters of 1 micron (PM_{1}), 2.5 micron ($PM_{2.5}$), 4 micron or respirable particles (PM_{4}), 10 micron or thoracic particles (PM_{10}), and total suspended particulates (TSP). DustTrak II monitors can provide real-time readings of $PM_{2.5}$ or any other mass fraction if the impactor for the specified particle size is installed in the monitor. Both the DustTrak DRX and DustTrak II electronically record particulate data as specified in the “RunMode” menu on the instrument screen. Refer to EPA ERT SOP No. EPA-PROC-2078-20, “Operation of the DustTrak Aerosol Monitors; Desktop DRX Model 8533EP and Handheld DRX Model 8534” for comprehensive standard operating procedures for the DustTrak DRX (EPA, 2020c).

Single Point Monitors such as the SPM Flex can detect specific chemicals or classes of chemicals, depending on the Chemcassette cartridge installed. A wide range of Chemcassettes are available for toxic gases; a full list is available on the manufacturer’s website. The SPM Flex can provide real-time readings of concentrations of the specified gas or gas family and electronically logs the data for download after the monitoring event. Refer to EPA ERT SOP No. EPA-PROC-2071-20, “Operation of the SPM Flex Gas Detector” for comprehensive standard operating procedures for the SPM Flex (EPA, 2020d).

Mercury Vapor Analyzers (MVAs) such as the Lumex RA-915+ Mercury Analyzer, RA-915M Mercury Analyzer, and the Jerome J505 Mercury Vapor Analyzer are capable of detecting mercury vapor in ambient air at concentrations from 2 to 200,000 nanograms per cubic meter (ng/m^3) (Lumex RA-915M) and 0.05 to 500 micrograms per cubic meter ($\mu g/m^3$) (Jerome J505 MVA). Both the Lumex RA915-M and Jerome J505 MVA provide real-time readings of mercury vapor concentrations and have the ability to electronically log the data for download after the monitoring event. When operated in “Monitoring” mode, the Lumex RA915-M is capable of running for a designated amount of time with periodical zero checks and datalogging. Refer to EPA Scientific, Engineering, Response and Analytical Services (SERAS) SOP No. 1729, “Operation of the Lumex RA-915+ Analyzer for Measuring Mercury Vapor Concentrations in Air” and EPA ERT SOP No. EPA-PROC-2080-20, “Operations of the Jerome J505 Mercury Analyzer” for comprehensive standard operating procedures for the Lumex RA-915+, Lumex RA-915M, and Jerome J505 MVA (EPA 2016; EPA 2020e)

2.2 DETECTION METHODS

The MultiRAE Pro and AreaRAE Pro electrochemical sensors measure the concentration of the toxic gas within an external circuit using oxidation and reduction reactions. Electrochemical sensors for oxygen (O_2) are available as well. The toxic sensor must be calibrated to the specific toxic gas the sensor is

designed to measure, or a member of the group of compounds the sensor is designed to measure. While some sensors are toxic compound specific, all sensors may respond negatively or positively to other compounds in the environment. Some electrochemical sensors such as nitric oxide (NO) and ammonia (NH₃) require a bias voltage to detect the gas and require an equilibrium (or warm-up) time of at least 6 hours after installation. Unbiased sensors require at least 10 minutes to stabilize.

There are two types of combustible sensors available for detecting LEL and methane, protected catalytic bead sensors and non-dispersive infrared (NDIR) sensors. Protected catalytic bead sensors contain a catalyzer that allows for oxidation of the combustion gas at temperatures well below their normal flash point. NDIR sensors utilize light and measure IR absorption at specified wavelengths to estimate concentrations of a gas. While catalytic bead sensors are not sensitive to only one chemical, NDIR sensors rely on chemical-specific IR absorbance to detect a single combustible gas.

TSI DustTrak monitors utilize light-scattering laser photometers to determine mass-based measurements of particulates. Both the DustTrak II and the DustTrak DRX draw aerosols into a sensing chamber using a diaphragm pump, and a sample flow is illuminated by a laser light. While the DustTrak II utilizes the voltage across the photodetector to determine particulate concentration, the DustTrak DRX utilizes the individual pulses from the photometer to make single particle measurements, allowing the monitor to simultaneously measure both the aerodynamic diameter of an individual particle, as well as its mass.

The Honeywell SPM Flex draws a gas sample to the Chemcassette tape-based optical gas detection system. The SPM Flex uses an optical scanning system to detect the presence of a gas based on a color change on the installed Chemcassette. Chemcassettes are available for a wide range of both specific toxic gases and classes of toxic gases; a list of available cassettes can be found in the SPM Flex User's Manual. It is important to note that when using a Chemcassette designed to monitor for a class of toxic gases, such as a mineral acid Chemcassette, the monitor is configured to report the concentration of one specific member of the target compound class. However, a color-change will be induced in the Chemcassette by any member of the target compound class. The specific configuration of the SPM Flex monitor, limit of detection, and instrument response time can vary widely by both Chemcassette and the specific target compound.

The Lumex RA-915+ and RA-915M utilize differential Zeeman atomic absorption spectrometry using high frequency modulation of light polarization (ZAAS-HFM). A mercury lamp, which is a radiation source, is placed into a permanent magnetic field. Two beams are propagated from the lamp to a photodetector, one passes through an analytical cell and one does not. When mercury vapor from a

sample is introduced into the analytical cell, the difference between the intensities of the beams increases proportionately to mercury vapor concentration. The Jerome J505 MVA uses atomic fluorescence spectroscopy (AFS), which uses a light source with a wavelength of 254nm. Any mercury present in the sample will absorb and re-emit the light, which is then measured by a photo multiplier tube (PMT)

2.3 LIMITATIONS

Toxic sensors in the MultiRae Pro and AreaRae Pro have the following limitations:

- Cannot be exposed to precipitation or operate in temperatures outside of the 14 to 113-degree Fahrenheit (°F) range.
- Cannot be used when liquid may be inadvertently drawn into the probe.
- Electrochemical sensors can respond to chemicals other than those they are designed to detect. Some sensors, such as Formaldehyde (HCHO) and HCN, have extremely high cross-sensitivities. Sensor-specific Rae Systems Technical Notes should be consulted prior to use. Rae Systems Technical notes are available on the manufacturer's website.
- When used in the field, it is recommended that the instrument's accuracy be checked on a daily basis. Silicones, phosphates and phosphorus containing compounds, acidic or basic atmospheres, and overexposure (especially for oxygen (O₂) and VOC sensors) can damage sensors or the PID lamp.
- Most Rae System toxic sensors have a life span of two years.

Combustible sensors in the MultiRae Pro and AreaRae Pro have the following limitations:

- Protected catalytic bead sensors must be used in an environment with sufficient oxygen (greater than 10%) in order to operate.
- Protected catalytic bead sensors do not distinguish between combustible gases. If concentrations of a specific combustible gas are desired, use an NDIR sensor for the desired gas.
- Combustible sensors have a shorter life span (about 1 year) than electrochemical sensors. Ensure that the sensor is not expired prior to use.
- Combustible sensors are susceptible to sensor poisoning, in which the presence of certain compounds (typically silicones and phosphorous-containing compounds) can degrade the performance of the sensor over time, resulting in under-reporting of combustible atmospheres.

Photometric particulate monitors such as the DustTrak DRX have the following limitations:

- High humidity or fog may cause elevated particulate readings. The use of the Heated Inlet Sample Conditioning module may mitigate these issues by maintaining a stable relative humidity level.
- Measurement accuracy is dependent on a wide particle size distribution and by the optical characteristics of the particles, such as density, size, shape, and composition.

Single Point Monitors such as the SPM Flex have the following limitations:

- Chemcassette tapes are highly sensitive to rain, fog, humidity, and condensation.

- Cannot be used in temperatures outside of the 32 to 104 °F range.
- Operation is calibrated for use at altitudes below 3,000 feet. Work at elevations above 3,000 ft may require manufacturer calibration.
- Not all Chemcassette reactions are chemical specific. A colorimetric indicator may react with several similar chemicals, but the concentration determined by the monitor will be for a specific compound, based on a compound-specific conversion factor.
- Chemcassettes have a short life span and often need to be refrigerated or stored in freezers. Additionally, there is a relatively long lead-time to obtain new Chemcassettes.

The Lumex RA-915+, Lumex RA-915M, and Jerome J505 MVA have the following limitations:

- MVAs should never be exposed to metallic mercury.
- The Lumex RA-915+ and Lumex RA-915M should not be used for long durations in environments with high concentrations of mercury vapor (greater than 10,000 ng/m³). If mercury vapors are present at high concentrations, operate the Lumex instruments in “High Concentrations” measuring mode or use a Jerome J505 MVA.
- Some interference with high levels of VOCs has been observed and noted. If operating any MVA in an environment with VOCs present, consider collecting air samples for laboratory analysis via National Institute for Occupational Safety and Health (NIOSH) Method 6009, *Mercury*.
- MVAs are sensitive to environmental conditions. If operating an MVA in an environment with variable environmental conditions, re-zero the instrument frequently. The MVA should never be exposed to water or dust.

3.0 PROCEDURES

3.1 TESTING AND CALIBRATION PROCEDURES

Each air monitoring instrument should be calibrated according to the manufacturer’s specifications.

General procedures applicable to most equipment are as follows:

- Equipment should be thoroughly cleaned, and then calibrated and tested before the startup of monitoring at each site.
- Equipment should be calibrated and tested using manufacturer-provided calibration gas and calibration connector kits.
- Batteries should be charged before the startup of field work, and the battery charge level should be checked at the start of each day. The battery charge life will vary depending on the monitoring instrument used, the application, and environmental conditions such as the temperature. Some instruments are equipped with an adapter that will allow the unit to be plugged into a car charger or charge from a car battery. It is recommended that extra batteries be kept on hand when conducting field work.
- Calibration and testing of field equipment should be documented every time it is performed. Calibration and testing information should be recorded in field logbooks, field data sheets, or electronic data capture forms.

- If testing and calibration measurements are out of tolerance, the instrument must be serviced or repaired.
- The manufacturer-recommended factory calibration schedule should be followed. If an instrument is due for factory calibration it should not be used in the field.

3.2 FIELD MEASUREMENT PROCEDURES

Each air monitoring instrument should be operated according to manufacturer's specifications. The actual field procedures will vary depending on the type of monitoring to be conducted. Many instruments are affected by moisture, humidity, and dust. Additionally, many instruments include a datalogging option. Even if wireless telemetry is utilized, the datalogging option should be selected to prevent losing air monitoring data. General procedural summaries and processes for air monitoring associated with initial surveys and offsite or perimeter monitoring are presented below.

3.2.1 Initial Surveys

Initial surveys are conducted upon first entry to an area with a potentially hazardous atmosphere. Initial surveys are performed relatively rapidly and are a screening process for collecting preliminary data to use for determining levels of PPE, establishing work zones, and establishing contaminated areas for further monitoring or sampling.

In most cases, project teams will have prior knowledge of the site and site contaminants, allowing air monitoring instrumentation to be selected based on the site-specific contaminants of concerns. When entering unknown environments, utilize the EPA Emergency Response Technical Group "Hazard Evaluation Flow Chart for Unknown" (EPA 2005). Intrinsically safe instrumentation should be used when there is a threat of atmospheres that may be explosive or conducive to ignition.

General procedures for conducting initial surveys are as follows:

- Following the instrument manual, calibrate and test air monitoring equipment. Multiple instruments may be necessary depending on the nature of the site.
- Record calibration information, site name, date and time, and pertinent weather information in a field logbook or on field data sheets.
- Approach the entrance to the site from the upwind direction, if possible. At the entry of the site, record the readings from each instrument in the breathing zone. Negative or non-detect results should also be recorded to demonstrate that the measurement was taken.
- Enter the site and record a measurement in each area of interest (ex: spill areas, frequently utilized spaces, current or historical chemical storage areas).

- Determine if measurements indicate sustained concentrations of contaminants in the breathing zone which are above action levels specified in the site-specific health and safety plan, or which otherwise do not meet healthy and safety criteria. Upgrade the level of PPE, implement engineering controls, and/or stop work if necessary.
- Once the initial survey is complete, download all instrument data and save in the project folder for site records or for future analysis.

Information obtained during initial surveys may lead to further monitoring. A more comprehensive survey and analysis for specific compounds may be warranted.

3.2.2 Off-Site and Perimeter Monitoring

Off-site and perimeter monitoring is typically conducted with the same instrumentation that is used for onsite monitoring. Since air is dynamic by nature, physical boundaries do not necessarily delineate the extent of contamination or the boundary of an area affected by a release. Monitoring at the perimeter of the site, or at locations off site provides information about pollutant migration. General procedures for conducting off-site and perimeter monitoring are as follows:

- Following the instrument manual, calibrate and test air monitoring equipment. Multiple instruments may be necessary depending on the nature of the site.
- Record calibration information, site name, date and time, and pertinent weather information in a field logbook or on field data sheets.
- Identify perimeter or offsite locations for monitoring. Generally, cardinal directions are acceptable for perimeter monitoring. Monitors may be adjusted or added based on wind direction and wind speed, or the presence of priority populations for monitoring, such as sensitive receptors.
- Once monitoring locations have been determined, place instruments in the breathing zone and record monitoring start times and readings. Ensure instruments are not in the way of traffic, work, or other activities that could damage or disturb them.
- If the monitoring period is prolonged, check on the instrument periodically to ensure proper function and accuracy. If sensor drift is suspected or observed, recalibrate the instrument and restart monitoring.
- At the end of the monitoring period, record the monitoring stop time and readings.
- Download all instrument data and save in the project folder for site records or for future analysis.

Lack of detections or negative results should not be interpreted as complete absence of airborne contaminants. It is possible that the compound class the instrument detects is not present or that the concentrations of the compounds are below the instrument's detection limits. The instrument detection limits should be presented with all site data.

3.3 AIR MONITORING TELEMETRY

Many air monitoring instruments are capable of generating a real-time data stream that can be incorporated into telemetry systems for remote monitoring. Telemetry systems make use of wireless data transmission technologies to convey monitoring results to a central location for viewing and storage. Common telemetry systems used for transmitting air monitoring data include EPA ERT's VIPER system and Honeywell's ProRAE Guardian system. The VIPER system can be operated using either wireless local area networks (WLAN)/cellular system or 900 MHz radio modems. Numerous air monitoring instruments can be incorporated in the VIPER system, including DustTrak DRX monitors, SPM Flex monitors, and RAE Systems equipment (for a full list of supported monitoring equipment, see www.response.epa.gov/VIPER). The ProRAE Guardian system utilizes 900 MHz radio modems or WLAN to transmit data. The ProRAE Guardian system supports most RAE Systems instruments, including AreaRAE Pro and MultiRAE Pro monitors.

When monitoring instruments are configured as part of a telemetry network, monitoring data are compiled and visualized in a telemetry software. Most telemetry software applications provide tools for visualizing trends in monitoring results, configuring alarms when results exceed action levels, and store monitoring data in a database application. Data transmitted to the telemetry software can be viewed in near real-time from a remote location, including simultaneous viewing of multiple types of instruments, positioned at multiple locations.

3.4 ACCURATE RECORDING AND INTERPRETATION

Air monitoring instruments must be operated, and the data interpreted by individuals who understand the operating principles and limitations of the instruments. At hazardous waste sites, where unknown and multiple contaminants are frequently encountered, instrument readings should be interpreted conservatively.

The following guidelines promote accurate recording and interpretation:

- Calibrate instruments in accordance with the manufacturer's instructions before and after every use.
- Conduct additional monitoring at any location where a positive response occurs.
- Report any readings of zero as nondetectable (ND) rather than as "clean." Quantities of chemicals may be present but at concentrations that are not detected by the instrument.

3.5 VARIABLES AFFECTING AIR MONITORING

Complex environments containing many substances, such as those associated with hazardous waste sites, pose significant challenges to accurately and safely assess airborne contaminants. Several independent and uncontrollable variables can affect airborne concentrations and instrument performance. These factors must be considered when conducting air monitoring and interpreting data. The following variables must be considered:

- **Temperature:** An increase in temperature increases the vapor pressure of most chemicals. Generally, worst-case emission of VOCs and SVOCs occur on the hottest day of site activities.
- **Wind speed and direction:** An increase in wind speed can affect airborne contaminant concentrations near free-standing contamination or a release. Wind speed and direction impacts the extent and paths of plumes of airborne contamination.
- **Rainfall:** Water from rainfall can cap vapors, gases, or dust from a site, reducing concentrations of airborne contaminants.
- **Moisture:** Particulates, including finely divided hazardous solids, are highly moisture-sensitive. Moisture can vary significantly with respect to location and time and can impact the accuracy of monitoring results across all instruments.
- **Background emissions:** Background emissions from other activities in the proximity of a site can affect instrument readings. Operations such as vehicle maintenance, fueling facilities, and road or landscape work can affect readings associated with perimeter monitoring. Any potential outside sources of emissions should be recorded in the logbook or on field data sheets.
- **Work activities:** Work activities often require the mechanical disturbance of contaminated materials, which may change the concentration and composition of airborne contaminants at a site. Monitoring should be conducted at all phases of a project to ensure no work activities create hazardous work environments that require upgraded PPE, engineering controls, or stop work.

Consult the manufacturer's manual to determine the instrument-specific impacts of environmental conditions.

ATTACHMENT 1: EPA STANDARD OPERATING PROCEDURES

1. EPA SERAS SOP No. 1704 Revision 01 (SUMMA Canister Sampling)
2. EPA ERT SOP No. 2008 Revision 1.1 (General Air Monitoring and Sampling Guidelines)
3. EPA ERT SOP No. 2041 Revision 21 (Operation of Water Quality Multi-Parameters)



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B - Air Sampling Equipment and Media/Devices



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1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) provides guidance in developing and implementing sampling plans to assess the impact of hazardous chemicals on ambient or indoor air. It presents a standard approach to air sampling and monitoring and identifies equipment requirements. It is not within the scope of this SOP to provide a generic air sampling plan. Experience, objectives, site characteristics, and chemical characteristics will dictate sampling strategy.

Air monitoring or sampling involves measuring the air impact at selected locations during specific time periods. These measurements can be used to document actual air impacts during specific time intervals (i.e., during cleanup operations) or to extrapolate the potential "worst case" concentrations at that and similar locations over a longer time period than was sampled.

This SOP addresses issues associated with air monitoring or sampling, and discusses the typical monitoring instruments, air sampling kits, and approach to air sampling and monitoring.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives listed in the QAPP for a particular site.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 METHOD SUMMARY

Air monitoring is defined as the use of direct-reading instruments and other screening or monitoring equipment and techniques that provide instantaneous (real-time) data on the levels of airborne contaminants. There are numerous types of monitors for real-time air measurements. Examples of some widely used air monitoring equipment are hand-held photoionization detectors (PID), flame ionization detectors (FID), oxygen/combustible gas detectors, and toxic chemical sensors. These instruments are both manufactured individually and combined into multi-gas monitors.

Air sampling is defined as those sampling and analytical techniques that require either off- or on-site laboratory analysis, and therefore, do not provide immediate results. Typically, air sampling occurs after use of real-time air monitoring equipment has narrowed the number of possible contaminants and has provided some qualitative measurement of contaminant concentration. Air sampling techniques are used to more accurately detect, identify and quantify specific chemical compounds relative to the majority of air monitoring technologies.

Some typical situations where air monitoring and/or sampling provides useful data include the following: emergency responses, site assessments, and removal activities. Each of these activities has a related air monitoring/sampling objective that is used to determine the potential hazards to workers and/or the community.

- Emergency Response

Emergency responses are immediate responses to a release or threatened release of hazardous substances presenting an imminent danger to public health, welfare, or the environment (i.e., chemical spills, fires, or chemical process failures resulting in an uncontrolled release of hazardous substances). Generally



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these situations require rapid on-site investigation and response. A major part of this investigation consists of assessing the air impact of these releases.

- Removal Site Assessment

Removal site assessments (referred to as site assessments) are defined as any of several activities undertaken to determine the extent of contamination at a site and which help to formulate the appropriate response to a release or threatened release of hazardous substances. These activities may include a site inspection, multimedia sampling, and other data collection.

- Removal Actions

Removal actions clean up or remove hazardous substances released into the environment. Removal actions include any activity conducted to abate, prevent, minimize, stabilize, or eliminate a threat to public health or welfare, or to the environment.

Personal risk from airborne contaminants can be determined by comparing the results of on-site monitoring and sampling to health-based action levels such as the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) and Acute Exposure Guideline Levels (AEGs). Residential risk can be determined by comparing the results of off-site monitoring or sampling to health-based action levels such as those developed by the Agency for Toxic Substance and Disease Registry (ATSDR) or the EPA Risk-Based Regional Screening Levels (RSLs).

The extent to which valid inferences can be drawn from air monitoring/sampling depends on the degree to which the monitoring/sampling effort conforms to the objectives of the event. Meeting the project's objectives requires thorough planning of the monitoring/sampling activities, and implementation of the most appropriate monitoring/sampling and analytical procedures. These issues will be discussed in this SOP.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Preservation, containers, handling and storage for air samples are discussed in the specific SOPs for the technique selected. In addition, the analytical method (i.e., EPA, National Institute for Occupational Safety and Health [NIOSH], and OSHA Methods) may be consulted for storage temperature, holding times and packaging requirements. After sample collection, the sampling media (e.g., cassettes or tubes) are immediately sealed. The samples are then placed into suitable containers (e.g., whirl-paks, re-sealable bags, or culture tubes) that are placed into a shipping container.

Bubble wrap or another suitable material will be used when packing air samples for shipment. Vermiculite is not to be used due to potential asbestos content. Additional information may be found in Environmental Response Team (ERT) SOP, *Sample Packing and Shipment*.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Upwind sources can contribute to sample concentrations. Natural sources, such as biological waste, can produce hydrogen sulfide and methane that may contribute to the overall contaminant level. Extraneous anthropogenic contaminants (e.g., burning of fossil fuels; emissions from vehicular traffic, especially diesel; volatile compounds from petrochemical facilities; and effluvia from smoke stacks) may also contribute to the overall contaminant level. Air sampling stations, therefore, should be strategically placed to identify contributing sources.



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Photoreactivity or reaction of the parameters with non-related compounds of concern may occur resulting in a positive or negative bias to the analytical results. Some sorbent media/samples should not be exposed to light during or after sampling due to photochemical effects (e.g., polycyclic aromatic hydrocarbons [PAHs]). Always refer to the analytical method or SOP for interferences, potential problems, and any special sample preservation requirements.

Various environmental factors, including humidity, temperature and pressure, also impact the air sampling methodology, collection efficiency and detection limit. Since the determination of air contaminants is specifically dependent on the collection parameters and efficiencies, the collection procedure is an integral part of the analytical method.

Detection limits (DLs) and reporting limits (RLs) depend on the contaminants being investigated and the particular site situation. It is important to know why the data are needed and how the data will be used. Care should be taken to ensure the DLs and/or RLs are adequate for the intended use of the final data.

Some equipment may be sensitive to humidity and temperature extremes.

5.0 EQUIPMENT/APPARATUS

5.1 Direct Reading Instruments (Air Monitoring Instruments)

There are two general types of direct reading instruments: portable screening devices and specialized analytical instruments. Generally, all these techniques involve acquiring, for a specific location or area, continuous or sequential direct air concentrations in either a real-time or semi-real-time mode. The document, "Guide to Portable Instruments for Assessing Airborne Pollutants Arising from Hazardous Waste Sites" (OIML 1991), provides additional information about air sampling and monitoring. The hazard levels for airborne contaminants vary. See the ACGIH TLVs and the OSHA PELs for safe working levels. Common screening devices are described in Appendix A.

In years past older instruments were not capable of acquiring simultaneous concentration readings at multiple locations. USEPA-ERT has developed the VIPER wireless sensor communication system utilizing commercially available hardware in conjunction with standard air monitoring instrumentation. The VIPER system allows data from multiple instruments and multiple types of instrumentation to be collected and displayed in a common platform in near real-time.

VIPER is a wireless network-based communications system designed to enable real time transmission of data from field sensors to a local computer, remote computer, or enterprise server and provide data management, analysis, and visualization enhanced by ERT custom software. Additional information is available to epa.gov employees on the EPA On-Scene Coordinator (OSC) Response website located at https://response.epa.gov/site/site_profile.aspx?site_id=5033 or by contacting ERTSupport@epa.gov.

5.2 Air Sampling Equipment and Media/Devices

The following sources of analytical methods are used for most environmental air sampling applications: *Manual of Analytical Methods* (NIOSH 2016), *American Society for Testing and Materials (ASTM) Methods*, *U.S. EPA Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air* (U.S. EPA 1999), and *OSHA Methods* (OSHA 1990, 1991).



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Additional air sampling references include *Industrial Hygiene and Toxicology, Fourth Edition* (Patty 1994) and *Air Sampling Instruments for Evaluation of Atmospheric Contaminants* (ACGIH 2001). These methods typically specify equipment requirements for sampling. Since air sampling is such a diverse technology, no single method or reference is best for all applications. Common sampling equipment and media/devices are described in Appendix B.

5.3 Tools/Material and Equipment List

In addition to equipment and materials identified in Appendices A and B, the following equipment and materials may be required to conduct air sampling and monitoring at hazardous waste sites:

- Site logbook
- Clipboard
- Chain of custody records
- Custody seals
- Air sampling worksheets
- Air monitoring worksheets
- Sample labels
- Small screwdriver set
- Aluminum foil
- Extension cords
- Glass tube cracker
- Multiple plug outlet
- Whirl-pak™ bags or culture tubes
- Teflon tape
- Calibration devices
- Tygon and/or Teflon tubing
- Surgical gloves
- Lint-free gloves
- Ice
- Sample container
- Camera
- Scribe Printer with paper

Use the following additional equipment when decontaminating glassware or air sampling equipment on site:

- Protective equipment (i.e., gloves, splash goggles, etc.)
 - Paper towels
 - Five-gallon buckets
 - Scrub brushes and bottle brushes

6.0 REAGENTS

Impinger sampling involves using reagents contained in a glass vial to absorb contaminants of concern (for example, NIOSH Method 3500 for formaldehyde uses 1 percent [%] sodium bisulfite solution). Impinger solutions vary and are method-dependent.

Reagents such as acetone and hexane are required to decontaminate glassware and some air sampling



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equipment. Decontamination solutions are specified in ERT SOP, *Sampling Equipment Decontamination*.

7.0 PROCEDURES

7.1 Air Monitoring Design

7.1.1 Initial Surveys

In general, the initial survey is considered to be a relatively rapid screening process for collecting preliminary data at hazardous waste sites. However, initial surveys may require many hours to complete and may consist of more than one entry.

Some information is generally known about the site; therefore, real-time instrumentation for specific compounds (i.e., detector tubes and electrochemical sensors) can be used to identify hot spots. Sufficient data should be obtained with real-time instruments during the initial entry to screen the site for various contaminants. When warranted, intrinsically safe or explosion-proof instruments should be used. An instrument capable of a broad-spectrum measurement of volatile organic compounds (VOCs) is also typically used during this survey. These gross measurements may be used on a preliminary basis to (1) determine levels of personal protection, (2) establish site work zones, and (3) map candidate areas for more thorough qualitative and quantitative studies involving air sampling.

In some situations, the information obtained may be sufficient to preclude additional monitoring. Materials detected during the initial survey may call for a more comprehensive evaluation of hazards and analyses for specific compounds. Since site activities and weather conditions change, a continuous program to monitor the ambient atmosphere must be established.

7.1.2 Off-Site Monitoring

Typically, perimeter monitoring with the same instruments employed for on-site monitoring is utilized to determine site boundaries. Because air is a dynamic matrix, physical boundaries like property lines and fences do not necessarily delineate the site boundary or area influenced by a release. Whenever possible, atmospheric hazards in the areas adjacent to the on-site zone should be monitored with direct-reading instruments. Monitoring at the fenceline or at varying locations off site provides useful information regarding pollutant migration. Three to four locations downwind of the source (i.e., plume) at breathing-zone height can provide a basic fingerprint of the plume. Negative instrument readings off site should not be interpreted as the complete absence of airborne toxic substances; rather, they should be considered another piece of information to assist in the preliminary evaluation. The interpretation of negative readings is instrument dependent. The lack of instrument readings off site should not be interpreted as the complete absence of all airborne toxic substances; rather, it is possible that the particular compound or class of compounds to which the monitoring instrument responds is not present or that the concentration of the compound(s) is below the instrument's DL.

7.2 Air Sampling Design

7.2.1 Air Sampling Strategy



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The goal of air sampling is to accurately assess the impact of a contaminant source(s) on ambient air quality. This impact is expressed in terms of overall average and/or maximum air concentrations for the time period of concern and may be affected by the transport and release of pollutants from both on- and off-site sources. The location of these sources must be taken into account as they impact the selection of sampling locations. Unlike soil and groundwater concentrations, air concentrations at points of interest can easily vary by orders of magnitude over the period of concern. This variability plays a major role in designing an air sampling strategy.

Downwind air concentration is determined by the amount of material being released from the site into the air (the emission rate) and by the degree that the contamination is diluted as it is transported. Local meteorology and topography govern downwind dilution. Contaminant emission rates can also be heavily influenced by on-site meteorology and on-site activities. All of these concerns must be incorporated into an air sampling strategy.

A sampling strategy can be simple or complex, depending on the sampling program objectives. Programs involving characterization of the pollutant contribution from a single point source tend to be simple, whereas sampling programs investigating fate and transport characteristics of components from diverse sources require a more complex sampling strategy. In addition, resource constraints may affect the complexity of the sampling design.

An optimal sampling strategy accounts for the following site parameters:

- Location of stationary as well as mobile sources
- Analytes of concern
- Analytical RL to be achieved
- Rate of release and transport of pollutants from sources
- Availability of space and utilities for operating sampling equipment
- Meteorological monitoring data
- Meteorological conditions in which sampling is to be conducted

The sampling strategy typically requires that the concentration of contaminants at the source or area of concern as well as background contributions be quantified. It is important to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks, as well as various other types of quality assurance/quality control (QA/QC) samples, can be utilized to determine other sources. The impact of extraneous sources on sampling results can frequently be accounted for by placing samplers upwind, downwind and crosswind from the subject source. The analytical data from these different sampling locations may be compared to determine statistical differences.

7.2.2 Sampling Objectives

The objectives of the sampling must be determined prior to developing the QAPP. Does the sampling strategy verify adequate levels of protection for on-site personnel, or address potential off-site impacts associated with the site or with site activities? In addition, the assumptions associated with the sampling program must be defined. These assumptions include whether the sampling is to take place under "typical," "worst case", or "one-time" conditions. If the conditions present at the time of sampling are different from those



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assumed during the development of the sampling plan, the quality of the data collected may be affected. The following definitions have been established:

- Typical: routine daily sampling or routine scheduled sampling at pre-established locations.
- Worst case: sampling conducted during meteorological and/or site conditions that have the greatest potential to result in elevated ambient concentrations.
- One-time: only one chance is given to collect a sample without regard to time or conditions. Qualitative data acquired under these conditions are usually applicable only to the time period during which the data were collected and may not provide accurate information to be used in estimating the magnitude of an air impact during other periods or over a long time interval.

The sampling objectives also dictate the DLs or RLs. Sampling methods for airborne contaminants will depend upon the nature and state (solid, liquid or gas) of the contaminant. Gases and vapors may be collected in aqueous media or adsorbents, in molecular sieves, or in suitable containers. Particulates and aerosols are collected by filters or impactors. The volume of sample to be collected is dependent upon an estimate of the contaminant concentration in the air, the sensitivity of the analytical method, and the standard or desired DL or RL. A sufficient amount of sample must be collected to achieve the desired DL without interference from other contaminants. Most importantly, the selected method must be able to detect the target compound(s).

7.2.3 Location and Number of Individual Sampling Points

Choose the number and location of sampling points according to the variability, or sensitivity, of the sampling and analytical methods being utilized, the variability of contaminant concentrations over time at the site, the level of precision required, and cost limitations. In addition, determine the number of locations and placement of samplers by considering the nature of the response, local terrain, meteorological conditions, location of the site (with respect to other conflicting background sources), size of the site, and the number, size, and relative proximity of separate on-site emission sources and upwind sources. The following are several considerations for sampler placement:

- Location of potential on-site emission sources, as identified from the review of site background information or from preliminary on-site inspections.
- Location of potential off-site emission sources upwind of the sampling location(s). Review local wind patterns to determine the location of off-site sources relative to wind direction.
- Topographic features that affect the dispersion and transport of airborne toxic constituents. Avoid natural obstructions when choosing air sampling station locations, and account for channelization around those obstructions.
- Large water bodies, which affect atmospheric stability and the dispersion of air contaminants.



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- Roadways (dirt or paved), which may generate dust that could mask site contaminants.
- Vegetation, such as trees and shrubs, which stabilizes soil and retards subsurface contaminants from becoming airborne. It also affects air flow and scrubs some contaminants from the air. Sometimes thick vegetation can make an otherwise ideal air monitoring location inaccessible.

Consider the duration of sampling activities when choosing the location and number of samples to be collected. For example, if the sampling period is limited to a few hours, one or two upwind and several downwind samples may be adequate, especially around major emission sources.

A short-term monitoring program ranges from several days to a few weeks and generally includes gathering data for site assessments, removal actions, and source determination data (for further modeling). Activities involved in a short-term sampling strategy must make the most of the limited possibilities for data collection. Consider moving upwind/downwind locations daily based on National Oceanic and Atmospheric Administration (NOAA) weather forecasts. Weather monitoring becomes critical where complex terrain and local meteorological effects frequently change wind direction. A number of alternatives can often fulfill the same objective.

Prevailing winds running the length of a valley usually require a minimum number of sampler locations; however, a complex valley may require more sampler locations to account for the wide variety of winds. At sites located on hillsides, wind will move down a valley and produce an upward fetch at the same time. Sampling locations may have to surround the site to measure the wind's impact.

Off-site sources may affect on-site monitoring. In this case, on-site meteorological data, concurrent with sampling data, is essential to interpreting the acquired data, and additional upwind sampling sites may be needed to fully characterize ambient background contaminant levels. Multiple off-site sources may require several monitoring locations, but if the sources are at a sufficient distance, only one monitoring location is needed.

Topography and weather are not the only factors to consider when selecting a sampling location; the sampling sites must be secure from vandals and mishap. Secure all sampling locations to the best extent possible in order to maintain chain of custody, and to prevent tampering with samples or loss of sampling units. High-volume sampling methods often require the use of 110 volt alternating current (VAC) electric power. When portable generators are used, the power quality may affect sampler operation. In addition, be aware that the generators themselves could be a potential pollution source if their placement is not carefully considered (i.e., use of a gas generator when collecting VOC samples).

7.2.4 Time, Duration and Frequency of Sampling Events

After choosing appropriate sampling or monitoring locations, determine the sampling frequency and the number of samples to be collected. The time of day, duration and frequency of sampling events is governed by:

- The effects of site activities and meteorology on emission rates
- The diurnal effect of the meteorology on downwind dispersion



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- The time period(s) of concern as defined by the objective
- The variability in the impact from other non-site-related sources
- Cost and other logistical considerations

The duration of the removal action and the number of hours per day that site work is conducted determine the time, duration, and frequency of samples. Short-term sampling programs may require daily sampling, while long-term programs may require 24-hour sampling every sixth or twelfth day. If the site will be undergoing removal activities 24 hours a day, continuous air monitoring or sampling may be warranted. However, if the site activities will be conducted for only eight hours a day and there are no emissions likely to occur during the remaining 16 hours, sampling would be appropriate prior to the start of daily activities, continuing during operations, and end at the conclusion of the daily activities. An off-peak sample collection can ensure that emissions are not persisting after the conclusion of daily cleanup activities. For some sites, emissions are still a factor several hours after daily site activities have been completed. Because of the typically decreased downwind dispersion in the evening, higher downwind concentrations than were present during daytime site activities may be detected. For sites where this is possible, the sampling duration needs to be lengthened accordingly.

Sampling duration and flow rate dictate the volume of air collected, and to a major degree, the RL. The analytical method selected will provide a reference to flow rate and volume. Flow rates are limited to the capacity of the pumps being employed and the contact time required by the collection media.

The duration or period of air sampling is commonly divided into two categories: (1) samples collected over a brief time period are referred to as "instantaneous" or "grab" samples that are usually collected in less than five minutes; and (2) average or integrated samples are collected over a significantly longer period of time. Integrated samples provide an average concentration over the entire sampling period. Integrated samples are not suited to determining cyclical releases of contaminants because periodic or cyclical events are averaged out by the proportionally long sampling duration.

7.2.5 Meteorological and Physical/Chemical Considerations

A meteorological monitoring program is an integral part of site monitoring activities. Meteorological data, which define local terrain impacts on air flow paths, are needed to interpret air concentration data. Meteorological data may be available from an existing station located near the site (i.e., at a local airport), otherwise a station should be set up at the site. These data will document the degree that samples actually were downwind and verify whether other worst-case assumptions were met. Meteorological parameters to be monitored are, at a minimum, wind speed, and wind direction. The remaining parameters primarily affect the amount of a contaminant available in the air.

- Wind Speed

When the contaminant of concern is a particulate, wind speed is critical in determining whether the particulate will become airborne, the quantity of the particulate that becomes airborne, and the distance the particulate will travel from the source. Wind speed also contributes to the volatilization of contaminants from liquid sources.



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- Wind Direction

Wind direction significantly influences the path of airborne contaminants. In addition, variations in wind direction increase the dispersion of pollutants from a given source.

- Temperature

Higher temperatures increase the rate of volatilization of organic and some inorganic compounds and affect the initial rise of gaseous or vapor contaminants. Therefore, worst-case emission of volatiles and semi-volatiles will likely occur at the hottest time of day, or on the hottest day of the site activities.

- Humidity

High humidity affects water-soluble chemicals and particulates. Humid conditions may dictate the sampling media used to collect the air sample or limit the volume of air sampled and thereby increase the detection limit.

- Atmospheric Pressure

Migration of landfill gases through the landfill surface and through surrounding soils is governed by changes in atmospheric pressure. In addition, atmospheric pressure will influence upward migration of gaseous contaminants from shallow aquifers into the basements or first floors of overlying structures.

In many cases, the transport and dispersion of air pollutants is complicated by local meteorology. Normal diurnal variations (i.e., temperature inversions) affect dispersion of airborne contaminants. Terrain features can enhance or create air inversions and can also influence the path and speed of air flow, complicating transport and dispersion patterns.

The chemical characteristics of a contaminant (i.e., molecular weight, physical state, vapor pressure, aerodynamic size, temperature, reactive compounds, and photodegradation) affect its behavior and can influence the method used to sample and analyze it.

8.0 CALCULATIONS

Volume is obtained by multiplying the sample time in minutes by the average flow rate. Sample volume should be indicated on the chain of custody record. Adjustments for temperature and pressure differences may be required.

Results are provided in parts per million (ppm), parts per billion (ppb), milligrams per cubic meter (mg/m^3) or micrograms per cubic meter ($\mu\text{g}/\text{m}^3$).

Refer to the analytical method or regulatory guidelines for other applicable calculations.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

Specific QA/QC activities that apply to the implementation of these procedures will be listed in the QAPP



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prepared for the applicable sampling event. The following general QA procedures will also apply:

1. All data must be documented on approved field data sheets, in a site logbook, and/or recorded electronically.
2. All instrumentation must be operated in accordance with operation instructions as supplied by the manufacturer, unless otherwise specified in the QAPP. Equipment checkout must be performed prior to operation and must be documented.
3. Records must be maintained, documenting the training of the operators that use instrumentation and equipment for the collection of environmental information.

9.1 QA/QC Samples

QA/QC samples provide information on the variability and usability of environmental sample results. Various QA/QC samples may be collected to detect error or potential sources of sample bias. QA/QC samples are submitted with the field samples for analysis to aid in identifying the origin of field and/or analytical discrepancies. Following the QA/QC sample analysis, a determination can be made as to how the analytical results should be used. Collocated samples, background samples, field blanks, trip blanks and lot blanks are the most commonly collected QA/QC field samples. Performance evaluation (PE) samples and blank spikes provide additional measures of data QA/QC control. QA/QC results may suggest the need for modifying sample collection, preparation, handling, or analytical procedures if the resultant data do not meet site-specific QA or data quality objectives. Refer to ERT SOP, *Quality Assurance/Quality Control Samples*, for further details, and suggested frequencies for submittal of QA/QC samples.

9.2 Sample Documentation

All sample and monitoring activities should be documented legibly in ink. Any corrections or revisions should be made by lining through the incorrect entry and by initialing the error. All samples must be recorded on an Air Sampling Worksheet or logbook. A chain of custody record must be maintained from the time a sample is taken to the final deposition of the sample. Custody seals demonstrate that a sample container has not been opened or tampered with during transport or storage of samples. Enter all pertinent data into Scribe and print a COC record from Scribe. Refer to ERT SOP, *Sample Documentation*, for further information.

10.0 DATA VALIDATION

Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. These data are essential to providing an accurate and complete final deliverable. The ERT contractor's Task Leader (TL) is responsible for completing the UFP-QAPP verification checklist for each project. The data generated will be reviewed and processed by the TL prior to distribution.

Results for QA/QC samples should be evaluated for contamination. This information should be utilized to qualify the environmental sample results accordingly with data quality objectives.



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11.0 HEALTH AND SAFETY

Based on OSHA requirements, a site-specific health and safety plan (HASP) must be prepared for response operations under the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, [29 CFR 1910.120](#). Field personnel working for EPA's ERT should consult the Emergency Responder Health and Safety Manual currently located at https://response.epa.gov/_HealthSafetyManual/manual-index.htm for the development of the HASP, required personal protective equipment (PPE) and respiratory protection.

The majority of physical precautions involved in air sampling are related to the contaminant sampled. Attention should be given when sampling in potentially explosive, flammable or acidic atmospheres. On rare occasions, the collection media may be hazardous; for example, in the instance where an acidic or basic solution is utilized in an impinger.

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13.0 APPENDICES

A – Portable Screening Devices and Specialized Analytical Instruments

B - Air Sampling Equipment and Media/Devices



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APPENDIX A

Portable Screening Devices and Specialized Analytical Instruments

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PORTABLE SCREENING DEVICES

The following represent typical examples of air monitoring technologies. These monitoring devices may exist as a stand-alone instrument utilizing a single technology or may be combined into a multi-gas meter.

- Total Hydrocarbon Analyzers

Total hydrocarbon analyzers used to detect a variety of VOCs at hazardous waste sites principally employ either a PID or an FID. Compounds are ionized by a flame or an ultraviolet lamp. PIDs depend on the ionization potential of the compounds of interest. PIDs are sensitive to aromatic and olefinic (unsaturated) compounds such as benzene, toluene, styrene, xylenes, and acetylene. Greater selectivity is possible by using low-voltage lamps (i.e. fewer compounds will be detected). The ionization potential of individual compounds can be found in the NIOSH Pocket Guide to Chemical Hazards or from the specific instrument manufacturer. These instruments are not compound-specific and are typically used as screening instruments. FIDs are sensitive to volatile organic vapor compounds such as methane, propanol, benzene and toluene, but FIDs respond poorly to organic compounds lacking hydrocarbon characteristics.

Examples of instruments included under this grouping include the TVA 1000 & TVA 2020 (FID and PID), and AreaRAE/AreaRAE Pro/MultiRAE Pro (PID as part of multi-gas meter).

- Oxygen and Combustible Gas Indicators

Combustible Gas Indicators (CGIs) provide efficient and reliable methods to test for potentially explosive atmospheres. CGI meters measure the concentration of a flammable vapor or gas in air and present these measurements as a percentage of the lower explosive limit (LEL). The measurements are temperature-dependent. The properties of the calibration gas determines sensitivity. LELs for individual compounds can be found in the NIOSH Pocket Guide to Chemical Hazards or from the specific instrument manufacturer. If readings approach or exceed 10% of the LEL, extreme caution should be exercised in continuing the investigation. If readings approach or exceed 25% LEL, personnel should be withdrawn immediately.

CGIs typically house an electrochemical sensor to determine the oxygen concentration in ambient air. Normally, air contains approximately 20.9% oxygen by volume. Oxygen measurements are of particular importance for work in enclosed spaces, low-lying areas, or in the vicinity of accidents that have produced heavier-than-air vapors that could displace ambient air. The meters are calibrated for sea level and may indicate a false negative (i.e., oxygen [O₂] content) at higher altitudes. Since the air has been displaced by other substances, these oxygen-deficient areas are also prime locations for taking additional organic vapor and combustible gas measurements. Oxygen-enriched atmospheres increase the potential for fires by their ability to contribute to combustion or to chemically react with flammable compounds and promote auto-ignition.

Examples of instruments included under this grouping include the AreaRAE/AreaRAE Pro/MultiRAE Pro (LEL and O₂ as part of multi-gas meter).

- Toxic Gas Sensors

Toxic gas sensors are compound-specific electrochemical sensors, designed and calibrated to identify and quantify a specific compound or class of compounds in either gaseous or vapor form. Cross-sensitivity to air pollutants not of interest may lead to erroneous results. Common toxic gas sensors include carbon monoxide, hydrogen sulfide, sulfur dioxide, nitric oxide, nitrogen dioxide, ammonia, chlorine, hydrogen cyanide, and phosphine.



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Examples of instruments included under this grouping include the AreaRAE/AreaRAE Pro and MultiRAE Pro (user-selected toxic sensors are components of multi-gas meter).

- Aerosol/Particulate Monitors

Aerosol/particulate monitors are utilized when the contaminant of concern is associated with particulates, and when responding to fires. The Thermo Scientific DataRAM-4 (DataRAM-4) is a Real-time Aerosol/Particulate Monitor that uses a dual-wavelength nephelometer whose light scattering sensing configuration has been optimized for the measurement of the fine particle fraction of airborne dust, smoke, fumes and mists in ambient, atmospheric, industrial, research, and indoor environments. The DataRAM-4 also has an integrated datalogger.

The Met-One e-BAM beta attenuation monitor employs the absorption of beta radiation by solid particles extracted from the airflow.

Both the DataRAM-4 and the e-BAM can be configured to measure total particulates, or PM₁₀ or PM_{2.5} fractions.

The TSI Dusttrak DRX is a light-scattering laser photometer that uses both particle cloud and single particle detection to differentiate mass fraction measurements of PM₁, PM_{2.5}, PM₁₀ and total particulates. It will output and log data from all four size categories at the same time.

- Colorimetric detectors

Colorimetric Tubes

A chemical detector tube is a hollow, tube-shaped, glass body containing one or more layers of chemically impregnated inert material. To use, the fused ends are broken off and a manufacturer-specified volume of air is drawn through the tube with a pump to achieve a given detection limit. The chemicals contained within the packing material undergo a chemical reaction with the airborne pollutant, if present, and produce a color change during the intake of each pump stroke. The concentration of a pollutant is indicated by the length of discoloration on a calibrated scale printed on the detector tube.

The instruments included under this grouping consist of Dräger Tubes.

Chemically-impregnated tapes (i.e. Chemcassettes)

A chemcassette is a chemically impregnated tape that reacts with a specific chemical or class of chemicals in a sample stream, if present, to generate a colorimetric response. The response is measured by an optical scanning device programmed to provide ppb or ppm results of a particular gas.

The instruments included under this grouping consist of the Single Point Monitor (SPM) or SPM Flex.

- Radiation Detectors

Radiation detectors determine the presence and level of radiation at a site. The meters use a gas or solid ion detection media that becomes ionized when radiation is present. The meters are normally calibrated to one probe. Meters that detect alpha, beta, and gamma radiation are available.

Examples of instruments included under this grouping consist of the Ludlum 2241 and AreaRAE Gamma.



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- Gold Film (Hydrogen Sulfide and Mercury Vapor) Monitors

Hydrogen sulfide (H_2S) and mercury (Hg) monitors operate on the principle that electric resistivity increases across a gold film as a function of H_2S or Hg concentration. These monitors provide rapid and relatively low detection limits for H_2S or Hg in air. After extensive sampling periods or exposure to elevated airborne concentrations of H_2S and Hg at a site, the gold film must be heated to remove contamination and return the monitor to its original sensitivity.

The instruments included under this grouping consist of the Jerome 431-X (Hg), Jerome 405 (Hg) and Jerome 631-X (H_2S).

- Differential Zeeman Atomic Absorption Spectroscopy Analyzers

These high sensitivity and selectivity instruments are portable multifunctional differential atomic absorption spectrometers with the direct Zeeman effect for interference-free measurement of mercury and benzene vapor concentrations in air and gases. The mercury analyzer uses atomic absorption spectrometry at 254 nanometers (nm) with Zeeman correction for background absorption and does not require gold amalgam pre-concentration and subsequent regeneration steps. The BA-15 uses differential absorption spectrometry with the direct Zeeman effect. Both instruments are intended for measuring mercury or benzene vapor concentrations in ambient air and in the air of residential and production areas, and can be used in stationary and continuous modes.

The instruments included in this grouping are the RA-915M and the RA-915+ mercury vapor analyzers as well as the BA-15 benzene vapor analyzer.



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APPENDIX B

Air Sampling Equipment and Media/Devices

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AIR SAMPLING EQUIPMENT

- High-Volume PS-1 Samplers

High-volume PS-1 samplers draw a sample through polyurethane foam (PUF) or a combination foam and XAD-2 resin plug, and a glass quartz filter at a rate of 5-10 cubic feet per minute (CFM; ft³/min) (144 to 282 liters per minute [L/min]). This system is excellent for measuring low concentrations of Semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), pesticides, or chlorinated dioxins in ambient air.

- Area Sampling Pumps

These pumps provide flow-rate ranges between 2-20 L/min and have a telescopic sampling mast associated with the sampling train. Because of the higher volume that this pump is able to collect, this pump is suitable for sampling low concentrations of airborne contaminants (i.e., asbestos sampling). These pumps are also used to support metals, pesticides, and PAH sampling methods, which require large sample volumes.

- Personal Sampling Pumps

Personal sampling pumps are reliable portable sampling devices that draw air samples through a number of different types of sampling media including resin tubes, impingers, and filters. Flow rates are usually adjustable from 1 to 4 L/min (or 0.01 to .75 L/min with a restrictive orifice) and can remain constant for up to 8 hours on one battery charge or continuously with an alternating current (AC) charger/converter.

- Canister Samplers

Evacuated canister sampling systems use the pressure differential between the evacuated canister and ambient pressure to bleed air into the canister. The sample is bled into the canister at a constant rate over the sampling period using a critical orifice, a mechanically compensated regulator, or a mass flow control device until the canister is near atmospheric pressure.



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AIR SAMPLING MEDIA/DEVICES

If possible, before employing a specific sampling method, consult the laboratory that will conduct the analyses. Many of the methods can be modified to provide results that best support the project objectives or to provide a wider range of analytical results.

- SUMMA Canisters

SUMMA canisters are highly polished passivated stainless steel cylinders. The SUMMA polishing process brings chrome and nickel to the surface of the canisters, which results in an inert surface. This surface restricts adsorption or reactions that occur on the canister's inner surface after collection. Alternatively, a fused-silica lining may be incorporated on the canister's inner surface (e.g. Silocan, Silcosteel). At the site, the canister may be paired with a flow controller to collect a time-weighted average sample over a given sample period (e.g. 24-hours) or opened directly to collect a grab sample. Typical applications use 6-liter Summa canisters for VOC and/or permanent gas analysis.

- Passive Dosimeters

Passive dosimeters are clip-on vapor monitors (samplers) in which the diffused contaminants are adsorbed on specially prepared active surfaces. Industrial hygienists commonly use dosimeters to obtain time-weighted averages or concentrations of chemical vapors, as they can trap over 130 organic compounds. Selective dosimeters have also been developed for a number of chemicals including formaldehyde, ethylene oxide, hydrogen sulfide, mercury vapor, nitrogen dioxide, sulfur dioxide, and ozone. Dosimeters must be sent to a laboratory for analysis.

- Polyurethane Foam (PUF)

PUF is a sorbent used with a glass filter for the collection of SVOCs such as pesticides, PCBs, chlorinated dioxins and furans, and polycyclic aromatic hydrocarbons (PAHs). Fewer artifacts (chemical changes that occur to collected compounds) are produced than with some other solid sorbents. Polyurethane foam (PUF) is used with the PS-1 sampler and U.S. EPA Method TO-13. PUF can also be used with personal sampling pumps when sampling for pesticides and PCBs following EPA Method TO-10A. Breakthrough of the more volatile PCBs and PAHs may occur when using PUF.

- Sampling Bags (Tedlar)

Sampling bags, like canisters, transport air samples to the laboratory for analysis. Samples are generally collected using a lung system, in which a pump creates a vacuum around the bag in a vacuum box (lung box), causing the sample to flow from a source into the bag. This method is used for VOCs, fixed gases (carbon dioxide [CO₂], O₂ and nitrogen [N₂]), sulfur compounds, and methane. If samples are shipped to an off-site laboratory, it is good practice to collect duplicate bags for each sample, minimizing sample loss due to sample bags breaking or leaking.

- Impingers

An impinger allows an air sample to be bubbled through a solution, which collects a specific contaminant by either chemical reaction or absorption. For long sampling periods, the impinger may need to be kept in an ice bath to prevent the solution from evaporating during sampling. The sample is drawn through the impinger by using a sampling pump or more elaborate sampling trains with multiple impingers.



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- Sorbent Tubes/Cartridges

A variety of sampling media are available in sorbent tubes, which are used primarily for industrial hygiene. A few examples are carbon cartridges, carbon molecular sieves, Tenax tubes, and tubes containing the XAD-2 polymer. Depending upon the sorbent material, tubes can be analyzed using either a solvent extraction or thermal desorption. The former technique uses standard laboratory equipment and allows for multiple analyses of the same sample. The latter technique requires special, but readily available, laboratory equipment and allows only one analysis per sample. In addition, thermal desorption typically allows for lower detection limits by two or more orders of magnitude. Whenever sorbent tubes are being used for thermal desorption, they should be certified as "clean" by the laboratory doing the analysis.

Thermally Desorbed Media

During thermal desorption, high-temperature gas streams are used to remove the compounds collected on a sorbent medium. The gas stream is injected and often cryofocused into an analytical instrument, such as a gas chromatograph (GC), for compound analysis:

- Tenax Tubes

Tenax tubes are made from commercially available polymer (p-phenylene oxide) packed in glass or stainless steel tubes through which air samples are drawn or sometimes pumped. These tubes are used in U.S. EPA Method TO-1 and volatile organic sampling trains (VOST) for volatile nonpolar organic, some polar organic, and some of the more volatile semivolatile organics. Tenax is not appropriate for many of the highly volatile organics (with vapor pressure greater than approximately 200 millimeter (mm) Hg).

- Carbonized Polymers

The carbon molecular sieve (CMS), a carbonized polymer, is a commercially available, carbon sorbent packed in stainless-steel sampling tubes through which air samples are drawn or sometimes pumped. These are used in U.S. EPA Method TO-2 for highly volatile nonpolar compounds that have low-breakthrough volumes on other sorbents. When high-thermal desorption temperatures are used with CMS, more variability in analysis may occur than with other sorbents.

- Mixed Sorbent Tubes

Sorbent tubes can contain two type of sorbents. Combining the advantages of each sorbent into one tube increases the possible types of compounds to be sampled. The combination of two sorbents can also reduce the chance that highly volatile compounds will break through the sorbent media. An example of a mixed sorbent tube is the combination of Tenax and charcoal with a carbonized molecular sieve. A potential problem with mixed sorbent tubes is the breakthrough of a compound from an earlier sorbent to a later sorbent from which it cannot be desorbed.

Solvent-Extracted Media

Solvent-extracted media use the principle of chemical extraction to remove compounds collected on a sorbent media. The chemical solvent is injected into an instrument, such as a GC, for analysis of compounds. Examples of solvent-extracted media follow:



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- Chemically Treated Silica Gel

Silica gel is a sorbent that can be treated with various chemicals. The chemically treated silica gel can be used to sample for specific compounds in air. Examples include the 2,4-dinitrophenylhydrazine (DNPH)-coated silica gel cartridge used with EPA Method TO-11A.

- XAD-2 Polymers

XAD-2 polymers usually are placed in tubes, custom-packed sandwich-style with polyurethane foam, and prepared for use with EPA Method TO-13 or the semi-VOST method. The polymers are used for the collection of semivolatile polar and nonpolar organic compounds. The compounds collected on the XAD-2 polymer are chemically extracted for analysis.

- Charcoal Cartridges

Charcoal cartridges, consisting of primary and backup sections, trap compounds by adsorption. The design of the cartridges enables ambient air to be drawn through both the primary and backup sections, but the backup section is used to verify that breakthrough of the analytes captured in the first section did not occur (and the sample collection was quantitative). Quantitative sample collection is evident by the presence of target chemicals on the first charcoal section and the absence of target chemicals on the second section. The adsorbed compounds must be eluted, usually with a solvent extraction, and analyzed by GC with a detector, such as a Mass Spectrometer (MS).

- Tenax Tubes

Cartridges are used in OSHA and NIOSH methods in a manner similar to charcoal cartridges but typically for less volatile compounds.

Particulate Filters

Particulate filters are used by having a sampling pump pass air through them. The filter collects the particulates present in the air, and the filter is analyzed for particulate mass, chemical composition, or radiological composition. Particulate filters are made from different materials that are described below.

- Mixed Cellulose Ester (MCE)

MCE is manufactured from mixed esters of cellulose which are a blend of nitro-cellulose and cellulose acetate. MCE filters are often used for metals sampling.

- Glass Fiber

Glass fiber is manufactured from glass fibers without a binder. Particulate filters with glass fiber provide high flow rates, wet strength, and solid holding capacity. Generally, the filters are used for gravimetric analysis of particulates.

- Polyvinyl Chloride

Particulate filters made with polyvinyl chloride are resistant to concentrated acids and alkalis. The low moisture pickup and light tare weight of these filters make them ideal for gravimetric analysis.



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- Teflon

Teflon is manufactured from polytetrafluoroethylene (PTFE). Particulate filters with Teflon are easy to handle and exceptionally durable. PTFE is the optimal choice for particle size-selective samplers.

- Cellulose

Particulate filters made with cellulose contain less than 0.01% ash. These filters are used to collect particulates.



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1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the procedures for assembly, calibration, usage and post-use verification of Multi-parameter Water Quality Meters. This SOP specifically covers the YSI® 650 MDS data logger with YSI 6920 sonde, which houses all the different sensors, and the Horiba® U-52, two of the typical units used by U.S. Environmental Protection Agency (EPA) Environmental Response Team (ERT) contractor personnel. These units consist of two pieces, the data logger and the sonde. These instruments are used to collect representative water quality data. The parameters that may be quantified include: temperature in degrees Celsius (°C), pH in standard units, dissolved oxygen (DO) in milligrams per liter (mg/L), conductivity in microsiemens per centimeter (µS/cm), turbidity in nephelometric turbidity units (NTU) and oxidation/reduction potential (ORP) in millivolts (mV). Always refer to each unit's operating manual for complete operating instructions. Due to the nature of this equipment and its use under different environmental conditions, data obtained will be considered screening data.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives (DQOs) listed in the QAPP for a particular site.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 METHOD SUMMARY

The multi-parameter water quality meters are used to obtain physical characteristics of both surface water and groundwater. Measurements can be collected by submerging the probe directly into the water, inserting the probe into a water sample, or through a flow cell. The instrument is calibrated prior to data collection and verified immediately following use in the field. Water quality measurements are transferred from the digital display into an equipment or site logbook or field datasheet. For further information refer to ERT SOP, *Logbook Documentation*. Data may be logged electronically for later download.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

When handling the data logger, it should be kept dry. Both the data logger and sonde should be protected from being damaged during routine fieldwork. Data loggers must be disconnected from the sonde before being stored. Sonde sensors must be stored with approximately 1/2 inch of tap water or pH 7 solution in the calibration and/or storage cup so that the sensors can remain moist without being immersed in liquid. The storage vessel must be sealed to minimize evaporation. The data logger and sonde must be stored at temperatures between -10 and 30°C with a relative humidity of under 80 percent (%), free from condensation. Additionally, the meter must be stored in areas void of dust, strong vibrations, or corrosive gases. The meters should not be stored in areas of extreme or fluctuating temperatures such as near air conditioners, direct sunlight, or in an area with strong wind.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Prior to field mobilization, the batteries of the unit should be checked and replaced or recharged as necessary. Batteries without sufficient charge may result in inaccurate measurements. If any parameter begins to drift during field measurements, consult the unit's operation manual or contact the manufacturer.

It is important to complete the instrument calibration and post-use verification procedures as soon as possible,



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at or near the sampling location or site base station. Changes in barometric pressure, altitude, or ambient air temperature will affect the accuracy of the instrument.

Where possible, work in a shaded area as the readout may become obscured by bright sunlight. If the display is left in direct sunlight, the screen will become unreadable. Prolonged exposure to sunlight may damage the display.

If moisture gets inside the data logging unit, the unit may become inoperable.

Contaminated calibration solutions and/or air bubbles on the optical surface of the probe can lead to calibration errors when measuring turbidity. Negative turbidity readings may occur of clean water samples if the probe was not cleaned properly when last returned from the field and then recalibrated. Suspended particles in water may cause the turbidity readings to fluctuate.

5.0 EQUIPMENT/APPARATUS

The following equipment is necessary for field operation:

- Water Quality Meter (data logger, sonde and connection cable)
- Storage/calibration cup
- Flow-through cell (optional based on sample type)
- Logbook
- Soft paper wipes
- Two gallon bucket (or similar)

The following equipment is necessary for calibration:

- Altimeter/barometer, calibrated in accordance with manufacturer's recommendations
- Scissors or pocket knife (for trimming DO membrane)
- National Institute of Standards and Technology (NIST) traceable thermometer (glass, -1 to 51°C)
- Ring stand
- Clamp

6.0 REAGENTS

The following reagents are required for proper calibration:

- Deionized or distilled water, for use as a "0" NTU turbidity standard, rinsing calibration cups and determining DO
- Potassium Chloride (KCl) Solution for replacement of DO membrane
- NIST-traceable pH buffer solutions, (4.00, 7.00, and 10.00 standard units [S.U.]), for the YSI
- NIST-traceable turbidity standard solutions, 100 NTU or 126 NTU standards – based on specific sonde, for the YSI
- NIST-traceable conductivity standard solution, 0.9 to 9.9 millisiemens per centimeter (mS/cm) standard
- NIST-traceable ORP powder, for the YSI and Horiba
- Multi-parameter calibration solution, for the Horiba U-52
- Sodium Sulfite powder for zero DO calibration.



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7.0 PROCEDURES

7.1 Assembly

The three major components of multi-parameter water quality meters are the data logger, data cable and sonde, which houses the probes. To assemble, first connect the data cable to the sonde by aligning the key on the data cable male connector to the slot in the sonde's connector head. Then connect the other end of the data cable to the data logger without forcing the pins into the connector. The meter is now ready for calibration.

7.2 Calibration

Calibration and/or verification and inspection of the water quality meter should be performed on a daily basis when in the field to adjust for changing field conditions.

The inspection and calibration of the water quality meters includes:

- Testing and calibration of probes
- Inspection and cleaning of seal areas
- Replacement of damaged O-rings
- Replacement of membranes and electrolytes, as needed
- Battery check or replacement
- Documentation of calibration and maintenance in equipment or site logbook

Refer to each unit's operation manual prior to calibration as calibration procedures vary. A multi-parameter solution can be used to calibrate the Horiba U-52 for pH, conductivity, turbidity, and dissolved oxygen or individual solutions can be used, also referred to as auto-calibration. See the Horiba U series manual for more information on auto calibration. The YSI uses individual solutions to calibrate the various sensors. For further information, follow sections 7.2.1 through 7.2.6 listed below.

7.2.1 Temperature Verification

Verification of the temperature sensor, the sensor is inserted into a bucket filled with water of a known temperature by using the NIST-traceable thermometer. Wait five minutes to allow the sensor probe and NIST-traceable thermometer to stabilize. Document the reading in the equipment or site logbook. Verification should be performed annually. If the displayed temperature is greater than ($>$) $\pm 5^{\circ}\text{C}$ from the reference thermometer, the unit should be returned to the manufacturer.

7.2.2 Dissolved Oxygen Calibration

Dissolved Oxygen (DO) is calibrated differently by the YSI and the Horiba instruments. For complete step by step details, refer to each unit's specific user manuals. The DO calibration should be performed every two months when not in normal use to verify that the probe is operational. During field use the calibration must be made daily to adjust for atmospheric and other changes that can alter DO readings.



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YSI

The DO probe is calibrated using either the Winkler titration method of an aqueous solution or the Percent Saturation method in air. The latter method avoids the use of additional chemicals and hardware and is summarized here. Consult the YSI *User Manual* for a detailed description of both methods.

Prior to DO calibration, determine the local barometric pressure in millimeters of mercury (mm Hg) with a calibrated altimeter/ barometer. The YSI meter will prompt the user to enter the barometric pressure. Place approximately three milliliters (mL) of water, or a damp sponge, in the bottom of the calibration cup. Place the probe end of the sonde into the cup, being careful not to submerge either the DO or temperature probe into the water. Ensure the DO probe is vented to the atmosphere by engaging only one or two threads into the calibration cup. Wait approximately 10 to 15 minutes for the air in the calibration cup to become saturated with water vapor and for the temperature to stabilize. The DO calibration procedure will also automatically calibrate the probe in milligrams/liter (mg/L). Document in the equipment or site logbook the barometric pressure and whether or not, the sensor calibrated.

Horiba

The DO calibration requires a two-point calibration. The first is a zero calibration using deionized water or tap water. The second point uses a mixture of 50 grams (g) of sodium sulfite to 1000 milliliters (mL) of water. DO concentrations are reported in mg/L and are temperature dependent. Refer to the chart in the Horiba user manual, which lists DO concentrations at a standard range of temperatures. Further information on preparing the proper span calibration can be found in the Horiba user manual. Document the whether or not the sensor calibrated in the equipment or site logbook.

7.2.3 Conductivity Calibration

For units manufactured by both YSI and Horiba, rinse the calibration cup and probes with deionized or distilled water followed by a small amount of the conductivity solution. Fill the calibration cup with a conductivity standard between 0.9 mS/cm and 9.99 mS/cm and then immerse the probe end of the sonde into the solution until past the vent hole. Allow the temperature to equilibrate and conductivity readings to stabilize for at least one minute before proceeding. Enter the theoretical calibration value used during calibration (e.g., 10 mS/cm) into the unit.

Following calibration, rinse the sonde in tap or deionized/distilled water. If the sensor fails to calibrate it may need to be replaced. For the complete step-by-step process and for troubleshooting, refer to the specific unit's operation manual. Document in the equipment or site logbook the concentration of conductivity solution used, its lot number and expiration date, and whether or not the sensor calibrated.

7.2.4 pH Calibration

Calibration procedures for pH are similar for the YSI and the Horiba instruments. For complete step-by-step details, refer to each unit's specific user manuals. A two-point calibration is performed within a specific calibration range, either the 4-7 range or the 7-



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10 range. Before beginning the two-point calibration procedure, the anticipated pH to be measured should be known. or either calibration range, record the calibration solutions used, their lot numbers and expiration dates in the equipment or site logbook.

Two-Point Calibration: Range 4 – 7

Rinse the calibration cup and sonde with deionized or distilled water. Fill the cup above the pH probe with the pH 7 buffer solution. Enter the actual pH value based on the calibration temperature. Document the pH value on the meter once the reading has stabilized. Rinse the cup with deionized or distilled water. Fill the cup with pH 4 buffer solution. Again enter the actual pH value based on the calibration temperature. Document the pH value on the meter once the reading has stabilized. Remove the sonde and rinse both the cup and the sonde with deionized or distilled water. The pH sensor is now calibrated and ready for use.

If the sensor fails to calibrate, the probe may need to be replaced. For troubleshooting, refer to the meter's operation manual.

Two-Point Calibration: Range 7 – 10

Rinse the calibration cup and sonde with deionized or distilled water. Fill the cup above the pH probe with the pH 7 buffer solution. Enter the actual pH value based on the calibration temperature. Document the pH value on the meter once the reading has stabilized. Rinse the cup with deionized or distilled water. Fill the cup with pH 10 buffer solution. Again enter the actual pH value based on the calibration temperature. Document the pH value on the meter once the reading has stabilized. Remove the sonde and rinse both the cup and the sonde with deionized or distilled water. The pH sensor is now calibrated and ready for use.

If the sensor fails to calibrate, the probe may need to be replaced. For troubleshooting, refer to the meter's operation manual.

7.2.5 Turbidity Calibration

YSI

A two-point calibration is performed to calibrate the turbidity sensor. First, rinse the calibration cup with deionized or distilled water. Fill the cup with 0 NTU distilled or deionized water past the turbidity probe. Agitate the sonde making sure no air bubbles adhere to the probe. Once calibrated, rinse the calibration cup with deionized or distilled water. Rinse the cup with a small amount of the 100 or 126 NTU turbidity standard, depending on which sensor is installed. Fill the cup above the turbidity probe with the 100 or 126 NTU turbidity standard. Agitate the sonde, making sure no air bubbles adhere to the probe. Once the reading has stabilized, confirm the calibration. The unit is now calibrated and ready for use.

If the sensor fails to calibrate, the probe may need to be replaced. For specific step-by-step instructions and troubleshooting, follow the each unit's operation manual. In the equipment or site logbook, record the calibration solutions used, their lot numbers and expiration dates along with whether or not the sensor calibrated in the field equipment or site logbook.



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Horiba

Turbidity is divided into three measurement ranges: 0.0 to 9.9 NTU, 10 to 100 NTU, and over 100 NTU. Calibration procedures are dependent on the range(s) of the water to be measured. For most field applications, only the 0.0 to 9.9 NTU range is necessary, which requires a two-point calibration (one zero point and one span calibration). The first standard is 0 NTU deionized or distilled water. Fill the cup with the 0 NTU distilled or deionized water past the turbidity probe. Agitate the sonde, making sure no air bubbles adhere to the probe. Once calibrated, rinse the calibration cup with deionized or distilled water followed by a small amount of the reference standard solution.

For calibration within the 0.0 to 9.9 NTU range, a known concentration of solution must be within the 0.0 to 9.9 NTU range. Instructions on the preparation of the 8.0 NTU standard solution is found in the Horiba operation manual. Also found in the operation manual are calibration procedures for other calibration ranges and multiple point calibrations. In the site logbook, record the lot and expiration dates of the turbidity standards used.

7.2.6 Oxidation-Reduction Potential Calibration

Horiba

First prepare the ORP calibration solution by agitating 250 mL of deionized water with one bag of ORP standard powder. For further details on preparing the solution, refer to the Horiba user manual. Rinse the calibration cup and sensor with deionized or distilled water, followed by a small amount of the ORP solution. Fill the calibration cup with ORP solution until just above the ORP sensor. Agitate the sonde, making sure no air bubbles adhere to the probe. Do not leave the ORP standard solution in the open air for more than an hour; doing so will require that the solution be discarded and replaced with fresh solution.

If sensor fails to calibrate, the probe may need to be replaced. For specific step by step instructions and troubleshooting, follow the each unit's operation manual.

YSI

There is no calibration of the ORP sensor for the YSI meter; however, the ORP sensor should be verified that it is functioning correctly. Using a 3682 Zobell solution, readings should be between 221 and 241 mV at normal ambient temperature. If the reading is outside of this range, then it should be returned to the manufacturer for service.

7.3 Field Measurements

7.3.1 Submersion

For collecting measurements directly from a water body, remove the storage cup and thread on the weighted guard, then immerse the probe. Use a rope or string to lower and raise the probe into the water. Never use the data cable to lower and raise the sonde into and out of water as this may damage the cable. Allow several minutes for the readings to stabilize to ensure accurate readings. Record the parameter values in a site logbook. When measurements are complete, remove the weighted guard and replace the storage cup.



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7.3.2 Sample Cup

The sample cup may be used to make measurements of grab samples. Fill the cup approximately $\frac{1}{4}$ full of the water to be sampled, agitate and discard the water. Then, fill the cup until it's nearly full, with the probe sensors completely covered. After allowing time for the values to stabilize, record the parameter values in a site logbook.

7.3.3 Flow-Through Cell

The flow-through cell is used to collect multi-parameter measurements while purging a groundwater monitoring well during low-flow sampling. Prior to collecting measurements, the first couple minutes of purging must be done outside of the flow-through cell to prevent sediments from entering the cell. This will help prevent possible false turbidity readings. The pumping rate must be adjusted so that no air bubbles are present. Measurements can be made at periodic intervals either manually or by programming the data logger. Parameter values are then recorded in a site logbook.

7.4 Post-Use Verification

Follow the same procedures for initial calibration, except for the adjustment of parameter values. Instead, record the readings for each parameter and document in a logbook. Post-verification ensures the reliability of the field measurements by demonstrating that the instrument calibration did not drift during the monitoring period. Any significant deviations ($\pm 10\%$) in the calibration status of the instrument should be incorporated into the final interpretation of the water quality data.

7.5 Decontamination

The following steps should be followed to decontaminate the unit after each field mobilization:

1. Clean the entire sonde and the data cable with a cloth and mild liquid detergent solution and then rinse with deionized or distilled water. If necessary, a soft brush or cotton swab may be used to clean between the probes. Repeat this step as many times as necessary to remove all visible contamination.
2. Add deionized or distilled water to the storage cup and fasten to the sonde.
3. Agitate the instrument gently to further remove any contaminants or detergent.
4. Wipe the pH probe with lens cleaner or a cotton swab. Do not use abrasive cloths to wipe the probe.
5. Repeat Steps 2 through 4 until the probes are clean. **Do not use acetone, organic solvents, nitric acid or harsh detergents to clean the instrument.** Once the unit is decontaminated, it is ready for calibration or storage. If calibrating, refer to Section 7.2 for calibration instructions. If storing the unit, refer to Section 3.0.
6. Due to limitations on decontamination methods, no samples should be collected directly from the water quality parameter device. Once the sample stream has achieved steady state conditions required for sampling, the water quality device must be removed prior to sampling.



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7.6 Maintenance

Maintenance schedules are followed as outlined by manufacturers' guidelines. The replacement of probes should be done by a qualified individual. See each unit's operation manual for maintenance schedules.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

Specific quality assurance/quality control (QA/QC) activities that apply to the implementation of these procedures will be listed in the QAPP prepared for the applicable monitoring event. The following general QC procedures will also apply:

- Equipment will be calibrated prior to field use and post-verified after field use as per Sections 7.2 and 7.4.
- All data must be documented in equipment or site logbooks as per ERT SOP, *Logbook Documentation*.
- Record the manufacturer lot numbers and expiration dates of all calibration standards used in the instrument logbook. Ensure all standards and solutions are not expired.
- The units are inspected quarterly in the equipment logbook to ensure they are functioning properly. This will allow the user time to find and replace defective probes or components before going into the field. If units are rented, a copy of the preventive maintenance and calibration done by the environmental rental company will be requested. Renting the unit does not reduce the number of QC checks that need to be performed.
- Records must be maintained, documenting the training of the operators that use the instrumentation and equipment for the collection of environmental information.

10.0 DATA VALIDATION

Results of the post-verification checks will be evaluated for instrument drift. This information will be used to qualify the environmental sample results according to the project's data quality objectives. There is no formal data validation procedure.

Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. This may include but is not limited to: location information, water quality parameter measurements, purging start and end times, water levels, depth to groundwater measurements, purge method and total volume pumped. These data are essential to providing an accurate and complete final deliverable. The Environmental Response Team (ERT) contractor's Task Leader is responsible for completing the UFP-QAPP verification checklist for each project.



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11.0 HEALTH AND SAFETY

Based on Occupational Safety and Health Administration (OSHA) requirements, a site-specific health and safety plan (HASP) must be prepared for response operations under the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, [29 CFR 1910.120](https://www.ecfr.gov/current/title-29/chapter-I/subchapter-B/part-1910/section-1910.120). Field personnel working for EPA's ERT should consult the Emergency Responder Health and Safety Manual currently located at <https://response.epa.gov/HealthSafetyManual/manual-index.htm> for the development of the HASP, required personal protective equipment (PPE) and respiratory protection.

12.0 REFERENCES

Horiba, Ltd. April 2009. Multi Water Quality Checker U-50 Series Instruction Manual. Website access, April 22, 2015.

YSI Incorporated. November 2011. 6-Series Multiparameter Water Quality Sondes, Revision J. Website access, April 22, 2015.

13.0 APPENDICES

A – Water Quality Meter Figures



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Water Quality Meter Figures

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FIGURE 1. Water Quality Meters

Example of the YSI 650 MDS data logger and 6920V2 sonde



Example of the Horiba U-52 Water Quality Meter



STANDARD OPERATING PROCEDURE APPROVAL AND CHANGE FORM

Scientific, Engineering, Response and Analytical Services
2890 Woodbridge Avenue Building 209 Annex
Edison New Jersey 08837-3679

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SERAS SOP Number 1704, Rev 1.0

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The top row of this table shows the most recent changes to the controlled document. For previous revision history information, archived versions of this document are maintained by the SERAS QA/QC Officer on the SERAS local area network (LAN).

History	Effective Date
Supersedes: SOP #1704, Revision 0.1, 07/27/95	11/16/15
Revised entire document to include both grab and time-weighted sampling	
Added additional test about the UFP-QAPP to 1.0 Scope and Application	
Expanded the data validation section to include data verification	
Removed Figure 1	



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SUMMA CANISTER SAMPLING

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- 3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE
- 4.0 INTERFERENCES AND POTENTIAL PROBLEMS
- 5.0 EQUIPMENT/APPARATUS
- 6.0 REAGENTS
- 7.0 PROCEDURES
 - 7.1 Grab Sample Collection
 - 7.2 Time-Weighted Average Collection
- 8.0 CALCULATIONS
- 9.0 QUALITY ASSURANCE/QUALITY CONTROL
- 10.0 DATA VALIDATION
- 11.0 HEALTH AND SAFETY
- 12.0 REFERENCES
- 13.0 APPENDICES

A - Typical Reporting Limits for Volatile Organic Compounds
B - Air Sampling Worksheet - SUMMA*

SUPERSEDES: SOP #1704; Revision 0.1; 07/27/95, US EPA Contract No. 68-C4-0022

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SUMMA CANISTER SAMPLING

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to describe a procedure for sampling of Volatile Organic Compounds (VOCs) in ambient air. The method is based on samples collected as whole air samples in SUMMA or equivalent passivated stainless steel canisters. The VOCs are subsequently separated by gas chromatography (GC) and measured by mass-selective detector or multi-detector techniques. This method presents procedures for sampling into canisters at final pressures below atmospheric pressure referred to as sub-atmospheric pressure sampling.

This method is applicable to specific VOCs and a limited set of other compounds that have been tested and determined to be stable when stored in subatmospheric pressure canisters. The volatile organic compounds that have been successfully collected in canisters by this method along with their reporting limits are listed in Appendix A. These compounds results are reported as parts per billion by volume (ppbv) and micrograms per meter cubed ($\mu\text{g}/\text{m}^3$).

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives listed in the QAPP for a particular site.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 METHOD SUMMARY

Subatmospheric pressure sampling uses an initially evacuated canister and mass flow controller to regulate flow. With this configuration, a sample of air is drawn through a sampling train comprised of components that regulate the rate and duration of sampling into a pre-evacuated SUMMA canister. Alternatively, subatmospheric pressure sampling may be performed using a fixed orifice, capillary or adjustable micro-metering valve in lieu of the mass flow controller arrangement for taking grab samples or time-integrated samples. Grab samples are typically collected during discrete odor events. For grab sampling, the canister valve is opened, and the vacuum inside the canister draws in an air sample in a few seconds. Time-integrated sampling is conducted over a specific period of time to acquire a specific volume of air. The most common use is for the collection of sub-slab soil gas, indoor and ambient air samples associated with vapor intrusion activities.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

Sample holding times must be determined prior to initiating field activities and are dependent on the compound (s) being analyzed. Canisters and orifices should be stored in a cool dry place and always be placed in their plastic/metal shipping boxes during transport and storage to protect the canisters from dents and/or punctures during transport.

Typically 6-liter (L) passivated canisters are used for vapor intrusion and/or odor events although 1-L canisters may also be used. After the air sample is collected, the canister valve is closed, an identification tag is attached to the canister and the canister is transported to a laboratory for analysis. Upon receipt at the laboratory, the canister tag data are recorded.

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4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Contamination may occur in the sampling system if canisters are not properly cleaned before use. Additionally, all other sampling equipment (e.g. flow controllers) must be thoroughly cleaned. Instructions for cleaning the SUMMA canisters and flow controllers are described in the Scientific, Engineering, Response and Analytical Services (SERAS) SOP #1739, *Procedures for SUMMA Canister and Flow Controller Cleaning*.

Care must be used with canister valves. Do not overtighten the valves.

Ambient air sampling during rainy weather may result in clogging of the flow controller filter causing reduction or stoppage of flow. Sampling during rainy weather should be avoided.

5.0 EQUIPMENT/APPARATUS

- Sampling inlet line (optional) - Teflon tubing to connect the sampler to the environment being sampled (e.g. sub-slab, ambient)
- SUMMA canister, Restek Corporation, PA, Model # 27420 or 27408 or equivalent - leak-free stainless steel pressure vessels of desired volume with valve and electropolished interior surfaces, certified clean by the laboratory for the analytes of interest and leak checked
- (Optional) Particulate matter filter, Swagelok, OH, Model SS-2F-K4-2 or equivalent - 2- μ m sintered stainless steel in-line filter.
- Mass flow controller, fixed orifice, capillary or adjustable micro-metering valve, Valco Instruments, TX, VICI Model 202 or equivalent - for grab samples or time-integrated samples.
- Vacuum gauge, certified annually, to record canister vacuum in inches of mercury
- Flow meter, accompanied by an annual certificate of analysis, to verify orifice flow rates (ADM3000 or equivalent)
- Wrench, 9/16"

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURE

7.1 Grab Sample Collection

A canister, which is evacuated to one atmosphere below ambient and fitted with a flow restricting device, is opened to the atmosphere containing the VOCs to be sampled. The pressure differential causes the sample to flow into the canister. This technique may be used to collect grab samples (duration of seconds). The typical steps for collecting a grab sample are as follows:

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1. With a 9/16" wrench, remove the brass fitting from the top of the canister.
2. Attach the vacuum gauge to the canister and open the canister valve.
3. Verify and record the "Initial" reading of the evacuated SUMMA canister. The evacuated canister should read no more than -29.5 inches ("") of mercury.
4. Ensure that the canister valve is fully closed before removing the vacuum gauge.
5. Place the SUMMA canister in desired location. If sampling from a vapor stream, connect inert tubing to canister sampling port.
6. Open sampling valve by turning knob counter clockwise until the knob moves easily.
7. An audible "hiss" may indicate that sampling has initiated. When the hissing stops, close valve and replace cap. Sample duration should be approximately 10 to 30 seconds.
8. Document sample collection information on the Air Sampling Worksheet (Appendix B)

7.2 Time-Weighted Average Collection

This technique may be used to collect time-integrated samples (duration of 1 to 24 hours). The sampling duration depends on the degree to which the flow is restricted.

1. With a 9/16" wrench, remove the brass fitting from the top of the canister.
2. Attach the vacuum gauge to the canister and open the canister valve.
3. Verify and record the "Initial" reading of the evacuated SUMMA canister. The evacuated canister should read no more than -29.5 "of mercury.
4. Ensure that the canister valve is fully closed before removing the vacuum gauge.
5. Check the flow rate of the orifice using a certified flow meter or a rotameter that has been checked against the primary flow meter.
6. Attach the flow controller to the top of the canister. Start the fitting by hand to avoid cross threading, then tighten firmly with a 9/16" wrench.
7. Open the valve on the canister counter clockwise and record the "start" time.
8. Monitor sampling progress periodically.
9. At the end of the sampling period, close the valve on the canister by turning clockwise until hand tight. Record the "end" time. While the ideal reading on the can gauge should be slightly negative, the actual can pressure will be tested with a calibrated gauge at the laboratory.
10. Remove the flow controller and put it into its appropriate shipping container.

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11. Replace the brass fitting on top of the canister.

12. Record the final vacuum of the canister and complete the Air Sampling Worksheet - SUMMA Canister.

8.0 CALCULATIONS

A flow control device is chosen to maintain a constant flow into the canister over the desired sample period. This flow rate is determined so the canister is filled to about 5-L in a 6-L-canister for sub-atmospheric pressure sampling over the desired sample period. The flow rate can be calculated by:

$$F = \frac{(P)(V)}{(T)(60)}$$

where:

- F = flow rate (cc/min)
- P = final canister pressure, atmospheres absolute (1 for atmospheric, non-pressurized sampling)
- V = volume of the canister (cm³)
- T = sample period (hours)

$$F = \frac{(5000)}{(24)(60)} = 3.5 \text{ cc / min}$$

9.0 QUALITY ASSURANCE/QUALITY CONTROL

Specific QA/QC activities that apply to the implementation of these procedures will be listed in the Quality Assurance Project Plan prepared for the applicable sampling event. The following general QA procedures will also apply:

1. All SUMMA canister sampling data, including the items listed in Section 10 must be documented in site logbooks or on field data sheets.
2. All equipment must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the QAPP. Equipment check-out and calibration is necessary prior to sampling and must be done according to the instruction manuals supplied by the manufacturer. The vacuum inside each canister must be checked prior to use to ensure no leaks have occurred. The pre-set flow rates set by the laboratory are checked prior to use to ensure that the proper volume of sample will be collected.

10.0 DATA VALIDATION

Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. This may include but is not limited to: Location, Sub-location, SUMMA ID number, orifice ID number, start and end pressures, NIST vacuum gauge ID number, flow rate, flow meter ID number, start and end times. These data are essential to providing an accurate and complete final deliverable. The SERAS Task Leader (TL) is responsible for completing the UFP-QAPP verification checklist for each project.

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11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health Administration (OSHA) or ERT/SERAS health and safety guidelines. More specifically, depending upon the site-specific contaminants, various protective programs must be implemented prior to some SUMMA canister sampling activities. The site health and safety plan (HASp) must be reviewed with specific emphasis placed on the protection program planned for the sampling activities. Standard operating procedures should be followed such as minimizing contact with potential contaminants in the vapor phase through the use of respirators and disposable clothing.

12.0 REFERENCES

EPA Method TO-15, *Determination of Volatile Organic Compounds (VOCs) in Air collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry Analysis (GC/MS)*, January 1999.

13.0 APPENDICES

- A - Typical Reporting Limits for Volatile Organic Compounds
- B - Air Sampling Worksheet - SUMMA Canister

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APPENDIX A
Typical Reporting Limits for Volatile Organic Compounds
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Typical Reporting Limits for Volatile Organic Compounds

Analyte	MW	CAS Number	Reporting Limits	
			ppbv	µg/m ³
Acetone	58.08	67-64-1	0.200	0.475
Benzene	78.11	71-43-2	0.020	0.064
Bromoform (Tribromomethane)	252.73	75-25-2	0.020	0.207
Bromomethane	94.94	74-83-9	0.020	0.078
2-Butanone (MEK)	72.11	78-93-3	0.020	0.059
1,3-Butadiene	54.09	106-99-0	0.020	0.044
Carbon Tetrachloride	153.82	56-23-5	0.020	0.126
Chlorobenzene	112.56	108-90-7	0.020	0.092
Chloroethane (Ethyl Chloride)	64.51	75-00-3	0.020	0.053
Chloroform	119.38	67-66-3	0.020	0.098
Chloromethane	50.49	74-87-3	0.020	0.041
Cyclohexane	84.16	110-82-7	0.020	0.069
Dibromochloromethane	208.28	124-48-1	0.020	0.170
1,2-Dibromoethane (EDB)	187.86	106-93-4	0.020	0.154
1,2-Dichlorobenzene	147.00	95-50-1	0.020	0.120
1,3-Dichlorobenzene	147.00	541-73-1	0.020	0.120
1,4-Dichlorobenzene	147.00	106-46-7	0.020	0.120
Dichlorodifluoromethane (Freon 12)	120.91	75-71-8	0.020	0.099
1,1-Dichloroethane	98.96	75-34-3	0.020	0.081
1,2-Dichloroethane	98.96	107-06-2	0.020	0.081
1,1-Dichloroethene	96.94	75-35-4	0.020	0.079
cis-1,2-Dichloroethene	96.94	156-59-2	0.020	0.079
trans-1,2-Dichloroethene	96.94	156-60-5	0.020	0.079
Dichloromethane (Methylene chloride)	84.93	75-09-2	0.020	0.069
1,2-Dichloropropane	112.99	78-87-5	0.020	0.092
cis-1,3-Dichloropropene	110.97	10061-01-5	0.020	0.091
trans-1,3-Dichloropropene	110.97	10061-02-6	0.020	0.091
1,4-Dioxane	88.11	123-91-1	0.020	0.072
Ethyl Acetate	88.11	141-78-6	0.020	0.072
Ethylbenzene	106.17	100-41-4	0.020	0.087
4-Ethyltoluene	120.19	622-96-8	0.020	0.098

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Typical Reporting Limits for Volatile Organic Compounds (cont'd)

Analyte	MW	CAS Number	Reporting Limits	
			ppbv	µg/m ³
Freon 113 (Trichlorotrifluoroethane)	187.37	76-13-1	0.020	0.153
Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	170.92	76-14-2	0.020	0.140
n-Heptane	100.20	142-82-5	0.020	0.082
2-Hexanone (MBK)	100.16	591-78-6	0.020	0.082
n-Hexane	86.18	110-54-3	0.020	0.070
Isopropyl Alcohol (2-Propanol)	60.10	67-63-0	0.200	0.492
Methyl Isobutyl Ketone (4-Methyl-2-pentanone)	100.16	108-10-1	0.020	0.082
Methyl Tert-Butyl Ether	88.15	1634-04-4	0.020	0.072
m & p -Xylene	106.17	108-38-3	0.040	0.174
Naphthalene	128.17	91-20-3	0.020	0.105
o-Xylene	106.17	95-47-6	0.020	0.087
Propene (Propylene)	42.08	115-07-1	0.200	0.344
Styrene	104.15	100-42-5	0.020	0.085
1,1,2,2-Tetrachloroethane	167.85	79-34-5	0.020	0.137
Tetrachloroethene	165.83	127-18-4	0.020	0.136
Tetrahydrofuran (THF)	72.11	109-99-9	0.020	0.059
Toluene	92.14	108-88-3	0.020	0.075
1,1,1-Trichloroethane	133.40	71-55-6	0.020	0.109
1,1,2-Trichloroethane	133.40	79-00-5	0.020	0.109
Trichloroethene	131.39	79-01-6	0.020	0.107
Trichlorofluoromethane (Freon 11)	137.37	75-69-4	0.020	0.112
1,2,3-Trichloropropane	147.43	96-18-4	0.020	0.121
1,2,4-Trimethylbenzene	120.19	95-63-6	0.020	0.098
1,3,5-Trimethylbenzene	120.19	108-67-8	0.020	0.098
Vinyl Acetate	86.09	108-05-4	0.020	0.070
Vinyl Chloride	62.50	75-01-4	0.020	0.051

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APPENDIX B
Air Sampling Worksheet - SUMMA Canister
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Scientific, Engineering, Response and Analytical Services
Lockheed Martin Corp., Edison, NJ
U.S. EPA Contract No. EP-W-09-031

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Air Sampling Work Sheet - SUMMA

Site: _____

WA# _____

Sampler: _____

U.S. EPA/ERT WAM: _____

Date: _____

SERAS Task Leader: _____

Sample #					
Location					
Sub-Location					
Summa #					
Orifice ID					
Start Pressure					
NIST Gauge S/N					
Flow Rate (Start)					
Flow meter					
Analysis/Method					
Time/Counter (Start)					
Time/Counter (Stop)					
Total Time					
End Pressure					
NIST Gauge S/N					
MET Station on Site?: Y / N					

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